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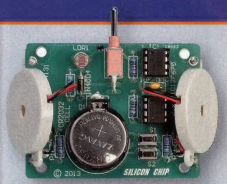

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Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Nicholas Vinen

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Kevin Poulter
Stan Swan
Dave Thompson

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Editorial office:
Unit 1, 234 Harbord Rd,
Brookvale, NSW 2100.

Postal address: PO Box 139,
Collaroy Beach, NSW 2097.

Phone (02) 9939 3295.

Fax (02) 9939 2648.

E-mail: silicon@siliconchip.com.au

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Publisher's Letter

Tracking commercial aircraft throughout the world

Our feature articles this month on tracking commercial aircraft throughout the world, starting on pages 12 & 40, document a truly startling development. You can now track tens of thousands of commercial aircraft flying around the world, in real time. The premier website for this information is **www.flightradar24.com** but there are others, listed on page 17 of this issue.

I have to say that I have spent an inordinate amount of time on this website, looking at aircraft flying in Australia and all over the world. And as you look at the display of hundreds or thousands of planes depicted on your computer screen, you can click on any one of them and immediately learn its flight number, airline, type, destination, estimated time of arrival, speed, rate of climb or descent and so on. You can view a picture of the actual aircraft and see a simulated view from the cockpit, based on Google Earth, together with some instrument readings.

As you look at the screen, you can see all the planes moving. Just think about the huge volumes of data that is being transmitted from all these planes, to be picked up by ADS-B receivers right around the world and then collated and processed to be presented on the **flightradar24.com** website.

Now I know that ADS-B was in the process of being implemented over the last five years or so, and in fact, we featured an article on this topic back in November 2008, but to see it all happening in real time right on your computer screen is truly mind-boggling.

If you watch over a sustained period you realise that incredible numbers of planes, like huge flocks of migrating birds, flow from the USA to Europe and Asia and back again, every 24 hours. And you can see it all unfolding before your very eyes. Absolutely incredible! Furthermore, you can even view it on your smart phone!

Just a couple of years ago I remember being amazed at being able to follow the status of any commercial flight, provided you knew the airline and flight number. It was and still is handy to check flight status at any time, without the hassle of phoning the airline office. But those websites only show the flight status and the estimated time of arrival. Now we have so much more. It is like AIS for commercial shipping (see SILICON CHIP, August 2009) but multiplied many times, since there are so many more aircraft than ships and more data is displayed.

If anyone had predicted that we would have real-time access to all this data just 10 years ago, they would probably have been regarded as a starry-eyed nut-case. Then again, maybe not. We should never pooh-pooh what might happen in the future, because no matter how outlandish the prediction might seem today, it just might come true, using technology that is not yet dreamed of.

Back to the present, if ADS-B and all it has made possible is not enough to boggle about, think about the cheap, tiny USB DVT-B dongles that you can use to monitor the ADS-B data being transmitted from every commercial aircraft at 1090MHz. That such advanced miniaturised RF circuitry, combined with truly elegant programming, puts this in the reach of anyone, whether they are technical or not, is again, a startling development. Less than five years ago, it would cost you about $1000.

That is on top of the previous articles on these dongles, about how you can use them in a Software-Defined Radio (See the May & June 2013 issues). Not only that, we have not yet finished with those dongles. There is still more interesting stuff that you can do with these ridiculously cheap USB devices. Stay tuned (and sorry about the pun).

I have used quite a few superlatives in this Publisher's Letter but that reflects the fact that we live in truly wonderful times. We should enjoy it.

Leo Simpson

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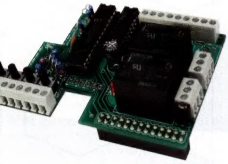

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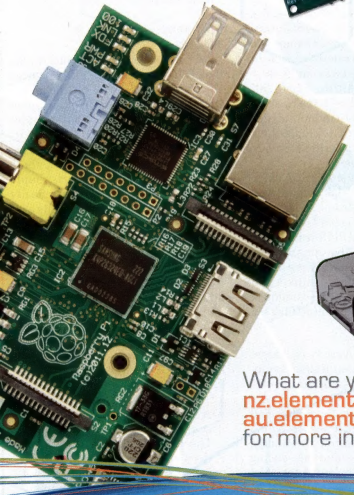

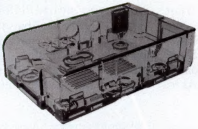

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Celebrating the centenary of AWA

Congratulations on the excellent article "100 Years of AWA" in the July 2013 issue of SILICON CHIP. Kevin Poulter has done some good work and I make no comment on his article but I should, for the sake of the historical record, point out two errors in the photo captions.

First, the Radiola model 611T (page 17) obviously doesn't tune to 223MHz; blame a missing decimal point. For the record, the AWA 7-band receivers all had the following bands: 540-1600kHz; 1.5-4.0MHz; 3.6-9.7MHz; 9.4-12.0MHz; 11.7-15.0MHz; 15.0-19.0MHz and 17.7-22.3MHz.

Second, the "technician" shown working on AWA's first prototype TV receiver (page 15) is, in fact, the engineer H. J. (Jim) Oyston and he is working not on a production prototype but an early 1950s experimental TV receiver. Jim was working with the well-known J. E. (Ernie) Benson in the Research Laboratory, where they were experimenting with television at the time.

When television receivers went into production, Jim became the chief TV development engineer in the Consumer Products Division. Ernie Benson was later better known for his outstanding work with loudspeakers, including the original sound reinforcing equipment in the Sydney Opera House.

Ross Stell,
AWA Veterans Association,
Kogarah, NSW.

Engineers made AWA the company it was

Thank you for a good article on AWA and their 100th anniversary, in the July 2013 issue. If it were not for AWA, Australia would have been in the backwaters of technology.

Like many technical people of my era, I was employed by one of the divisions of AWA and gained some very good knowledge in satellite communications. In my case, I was employed by AWA in the early 1970s to help fulfil a contract they had with the USAF for manning a satellite communications facility in Woomera, SA. This included six months training in the US which was a great experience.

Unfortunately, a story on AWA always features E. T. Fisk and not those who created the products. Mr Fisk, like Marconi and Sarnoff, was an entrepreneur who had the foresight to see a market and take the opportunities. These three gentlemen were driven by power and money. I think a good story would be about those engineers and technical people behind Fisk who created the products and made these events happen. These are the people who made AWA the company it was.

I would like to correct what possibly is just a typo in your reference to the public demonstrations in 1919 and 1920. The demonstrations were of wireless telephony (not telegraphy).

Ron Langhans,
Beaumont Hills, NSW.

AWA brand still lives on

Kevin Poulter didn't mention that the AWA brand name for consumer electronics still lives on, currently licensed by Woolworths. House-branded TVs sold in BIG W stores are AWA-badged, as is most of its premium house-branded AV range. Contrary to popular opinion, these are not "commodity" products simply labelled AWA. They are specifically made for Woolworths, with quite a lot of input from Woolworths' Australian QA team. Arguably, I am the closest thing to being the last AWA TV design engineer in Australia!

Sadly, even this modest acknowledgement of local technological know-how is coming to an end. Over

Help from the Serviceman

I have been entertained by The Serviceman articles for many years but now I have actually directly applied a fix described by The Serviceman.

The description of the Samsung 710V monitor problem in the May 2013 edition resembled one of the range of symptoms displayed by a Samsung 910T which has been languishing in my to-do cupboard for a couple of years. This monitor gradually degraded over a number of months with a variety of bizarre symptoms. Its penultimate symptom was the "Not optimum mode" message.

The 910T has both analog and digital inputs and it senses which is in use at switch-on. Eventually, it refused to get beyond the sensing cycle, not even displaying the "Not optimum mode" message.

My attempt to diagnose the cause at the time came to nothing and I put it aside "for later". After reading the Serviceman article and knowing that Samsung used the same basic controller in a range of monitors, I decided there was really nothing to lose by trying the fix. Soldering a resistor across those tiny IC pins was a challenge but to my surprise, it worked.

The monitor is now usable but it does sometimes play up after a couple of hours of use, so it's not a perfect fix. I wonder how many monitors have ended up as e-waste and land fill because of premature failure of that chip?

Peter Bennett,
Macarthur, ACT.

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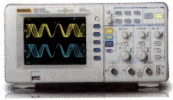

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Mailbag: continued

Comments on recent DVB-T dongle articles

As a subscriber to the magazine, I look forward to its arrival in the mailbox each month. The recent articles regarding the use of TV dongles as an inexpensive way of getting into the world of Software Defined Radio and the latest one for a matching Up-Converter have been of particular interest, as this is an area which has held a considerable fascination for me over recent years.

A similar article appeared in the ARRL publication *QST* earlier this year. Of course these dongles do not suit US TV standards but those who investigated their internal components also discovered that they could provide an inexpensive means of building an SDR. However, the explanations in Jim Rowe's articles are much more comprehensive and informative and the SILICON CHIP Up-Converter is a very professional design implementation.

Recently, I bought two different brands of dongle on eBay, and intend building the Up-Converter in the near future. By the way, the April 2013 article referred to the input plug required by the dongles as being either a PAL type or an SMB type. I think the latter should correctly be referred to as an MCX type plug. The SMB plug has an outside diameter (OD) of 2.6mm whereas the MCX OD is 3.6mm which mates perfectly with a dongle using an MCX receptacle.

I have also noted that some eBay advertisers are selling dongles with an on-board up-converter for those who don't wish to build a converter themselves.

On another topic the article on digital TV implies that broadcasters will eventually move to utilise the MPEG-4 transmission standard. The question must be raised as to how will existing owners of digital TV receivers handle such a change if their sets are no longer compatible with the signal. There will be potentially millions of sets affected by such a change.

Richard Kerr,
Millfield, NSW.

the past 12 months, sales of TV sets have pretty much "flat-lined" in Australia and it appears that just about everybody who wants a digital TV has now got one. Retailers like BIG W and Dick Smith are currently facing the situation where they can source "name-branded" TVs locally for about the same as they were paying to import house brands and without having to worry about warehousing, minimum order quantities, compliance, after-sales service and all that. Also, the market for high-end TVs has never really materialised (how many times have we seen *that* happen before?), so retailers are drastically cutting prices on those as well.

Apart from that, Dick Smith and BIG W used to share many of the product development tasks, since they used identical models for many of their house brands. However, now that Dick Smith are no longer owned by Woolworths, that partnership has ceased as well.

So it looks like the end of yet another era in Australian electronics. It was never exactly a big-time operation but at least we were doing something other than just blindly importing!

By the way, you may remember my 2005 articles about the 30th anniversary of the start of colour TV in Australia in 1975. My Dad's 1975 vintage AWA 14-inch colour TV (actually a Mitsubishi) is now 38, not out! So it's outlived him by 10 years and looks well set to see out the era of analog TV come next December.

Keith Walters,
Riverstone, NSW.

Climate science not challenged

In the Mailbag pages of the July 2013 issue you referenced a paper by Qing-Bin Lu as part of your comment on Len Cox's letter. If you think that challenges established science then you either have a poor understanding of climate science, haven't read Lu's paper or you haven't understood it (not that I would blame you; it's heavy going at 24 pages!).

Lu has been pushing much the same concept for years now, even though the errors in his reasoning have been pointed out repeatedly. His latest effort is again replete with circular arguments, misrepresentation of the conclusions of others and fundamental flaws in his arguments. These are well documented on the web and in the literature but his most glaring mistake is that he equates atmospheric temperature with global warming.

You don't have to read much climate science to know that atmospheric temperatures are the result of a global warming trend modulated by cyclic phases of ocean surface temperatures such as ENSO and PDO (Pacific Decadal Oscillation). The global warming that is measured in atmospheric temperature represents less than 3% of the total, with the majority (~90%) going to the oceans. Thus if Lu wants to show cause and effect between CFC concentration and global warming, he has to include all warming. If that is done, his correlation with CFCs breaks down and the correlation with CO_2 is reinforced – see **http://www.skepticalscience.com/graphics.php?g=65**

Before you start thinking that the heat going to the oceans is going to stay there long term, any study of climate records shows that is not the case. Even if there had been a correlation between CFC and total warming, that is not the same as causation and that's something you learn in high-school science. Mind you, the denier world seems oblivious to that fact.

How did such a flawed paper pass peer review? Good question! Part of the answer may be that the International Journal of Modern Physics B would have little expertise in climate science; its emphasis is the physics of exotic materials. There is also its impact factor, which is some measure of the level of scrutiny applied to the papers it accepts. IJMPB is rated at 0.36 (the lowest of any physics journal) whereas the likes of Nature is at 36.

Despite the Murdoch press and the rest of the denier industry focusing on Dr Lu's attempt at self-promotion, what they should have been trumpeting was the wonderful data coming

from Lake El'gygytgyn (Science 340 (6139): 1421-1427). That site is giving us a high-resolution, uninterrupted picture of the climate in Siberia going back 3.6 million years. What should be making the headlines is that the last time CO_2 was at present levels, the temperatures in Siberia were eight degrees warmer than present! You're right, the science isn't settled. That, as well as other recent evidence, is indicating that the models may well be too conservative in their predictions.

Michael Korsch,
Castle Hill, NSW.

About wireless microphones & digital TV

I write in regards to the recent article by Ross Tester titled "About Wireless Microphones and Digital TV" in the June 2013 issue.

I am a technical representative of a distributor of professional audio products, including wireless microphones, and as such I am very close to this issue. While I agree with the majority of the content of this article I feel the need to object to the implication that suppliers are attempting to dump soon to be non-compliant product on an unsuspecting market.

Ross seems to have based his research on product being offered entirely on eBay. He fails to mention any of the established distributors of name-brand product, most of who have been in the industry for many years and have invested heavily in public education around this issue.

Several years ago, a group of Australian distributors of wireless audio products (wireless microphones) came together to form an industry body called AWAG (Australian Wireless Audio Group), specifically to represent the views of uses of such equipment to the government and government authorities. AWAG works under the Australian Commercial & Entertainment Technologies Association (ACETA) and is completely self-funded; all work is effectively sponsored by the employers of the individuals involved.

AWAG has been actively involved with this issue for several years and has attended many meetings and submitted multiple responses to discussion papers, produced usage studies, economic impact studies etc. Further details are available here: **www.aceta.org.au/awag**

I personally have presented many public seminars on this topic at trade shows and industry association meetings over a six or seven year period. We have a dedicated website (**www.readyfordigital.com.au/**) specifically intended to provide up-to-date information to users of wireless audio devices and answer questions related to the digital dividend reallocation.

All AWAG member distributors voluntarily stopped supplying product that operated in the soon to be reallocated spectrum (694-820MHz) some four years ago, even though the government still has not yet made this a legal requirement. This is something AWAG has been and continues petitioning the government for, to protect customers from the possibility of less scrupulous suppliers who may try to offload soon to be non-compliant

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Mailbag: continued

Barco monitor available to restore

I have a Barco CTVM 3/51 Colour Monitor to offload as part of a clean-out. I'd rather it went to someone interested in restoring it. The monitor was working when decommissioned but has been sitting idle for quite some time.

This would be a good project for anyone interested in vintage radio or TV restoration. Any reasonable offer will be considered and whoever wants the monitor will need to arrange pick-up.

Barco CRT Monitors were the "Rolls Royce" of precision studio video monitors. The one I have here includes all service manuals plus two boxes of spares, including a second CRT which was refurbished but never used.

Anyone interested in this monitor can contact me on 0411 373 445.

Darryn Wiley,
Eastern Heights, Qld.

product on an unsuspecting market.

I guess what I'm saying is if you base your entire survey of wireless microphone suppliers on eBay, many of which are based overseas, it's no surprise that many are pushing soon to be non-compliant product with no disclosure. Buy via one of the reputable Australian distributors and you will not have to demand a guarantee in writing. We've already done that. Plus we have local warranty and support staff to back up the product should you encounter issues.

Jeff MacKenzie,
Jands Pty Ltd (AWAG member).

Comment: we're pleased that you agree with the majority of the content. Ross actually used some of Jands' information as background and fully understood that the "pro" market was being kept up-to-date with developments. We are much more concerned about the non-professional; the casual user who buys mainly on price.

And after talking to literally dozens of users in this market, Ross quickly became aware that none of these buyers understood that their equipment was about to be obsolete. His investigations showed that a large amount of soon-to-be-obsolete equipment was being offered by electronics retailers, music stores and others (a lot at "special" prices). And there were no warnings given, even when directly questioned in some cases.

You will note in the article that he warns against buying online. The suggestion that buyers ask for a guarantee in writing from a retailer is not unreasonable.

USB DVB-T dongles cheap to buy

Encouraged by your articles of April and May 2013, I decide to try DVB-T dongles as well. Paying less than $8 and using eBay, I got a really compact dongle that works faultlessly. It uses

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If you're an old timer (or even young timer!) into vintage radio, it doesn't get much more vintage than this. If you're a student of history, this archive gives an extraordinary insight into the amazing breakthroughs made in radio and electronics technology following the war years. And speaking of the war years, R & H had some of the best propaganda imaginable!

Even if you're just an electronics dabbler, there's something here to interest you.

NB: Requires a computer with DVD reader to view – will not work on a standard audio/video DVD player

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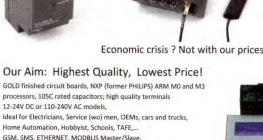

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Luis Orlandini,
Mermaid Waters, Qld.

Lilienfeld was inventor of transistor

I have just finished reading the April 2013 article on the Regency T-1 transistor radio and I take great umbrage at the phoney and bogus claims made as to the historical origins of the transistor. Like a bullet fired from a gun, time and time again this false history is repeated. It's like assassinating TRUE history over and over.

The TRUE inventor of the transistor is one Julius Edgar Lilienfeld; his historical achievement is not a matter of opinion but rather of historical fact and a matter of public record, namely his US patents: #1,745,175, #1,900,018 (the Field Effect Transistor!) and # 1,877,140 . . . and numerous others.

You can look these up using Google's advanced patent search and in particular, note the date; not the grant date but the filing date, from which subtract the months and months, shuttling back and forth to patent attorneys (remember, this was pre-word processors and e-mail) and months of laboratory time testing prototypes. Then the emergent early date of invention is truly startling in the evolution of solid-state electronics.

Though not stated explicitly, the inference in the article is that semiconductor refers to silicon or germanium. This, of course, is nonsense as there are a variety of materials and compounds that exhibit semiconductive properties – a fact that Lilienfeld clearly recognised and exploited in his first devices. The ONLY justifiable "first" that Bell Labs' Shockley & Co can claim is that they were the first to commercially exploit the technology which Lilienfeld had been unable to do. This, of course, has nothing to do with Lilienfeld crossing the finish line decades prior to Bell Labs.

It disgusts me that this false history is continually repeated and the rest of us just roll over like sheep by failing to challenge this mythical rubbish. It dishonours us all and more importantly, dishonours the considerable

Blu-ray player firmware modification

I recently purchased a Blu-ray player in Melbourne from a large chain store, which I won't name. As per their dealership requirements with the OEM, the player was set to the Oceania region.

As per common sense, I was supplied with an unlabelled "Firmware Upgrade" DVD that I was recommended to run as per the supplied written instructions which were also supplied to" de-regionise" the player. So, many businesses are coming to the party as they object to this stupidity as much as we the consumers do.

Fabian Stretton,
via email.

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Mailbag: continued

Hardware mod for DVD Blu-ray players

I was very interested reading Dave Thompson's Serviceman's Log on the subject of DVD zoning (June 2013, pages 53-54). Although there are now "Zone 0" players for playing discs from all four DVD regions, I don't think that this has been achieved for Blu-ray. There doesn't appear to be a "software hack" to achieve this. That doesn't mean however that you can't get players that can play all three Blu-ray regions.

I have just recently bought an Oppo 105A which can do this. However, it has been "hardware modified" to achieve this. To the best of my understanding, there are separate chips carrying the encoding for each Blu-ray region and what they have done is put all three chips into the player and then give you a sequence to switch your player to and from your desired region. I got my Oppo from Rapallo here in New Zealand.

Pete Sewell,
Hamilton, NZ.

achievements of a real genius. I want to believe that as a fraternal body of hobbyists and professionals we have both individually and collectively the personal integrity to stop blindly parroting these falsehoods and start speaking the TRUE history of who invented the transistor so that by this means, Julius Lilienfeld can have his throne rightfully restored to him.

Andre Rousseau,
Papakura, NZ.

M-Disc is a long-term storage medium

One of my hobbies is photography and I have for the last 10 years been exclusively using digital cameras. As a consequence, I am concerned about how to reliably store digital data in the long term. Current digital data storage options are Hard Disc, Memory Cards or Thumb Drives, Conventional Writable Optical Discs, and a new Optical Disc media, M-Disc.

Information gathered from the internet show the estimated life of the various types of data storage media as follows:

(1) Hard Disc; estimated life about five years but it could be 10 years if you are lucky, or it could fail in only a few days if you are unlucky.

(2) Memory Cards or Thumb Drives; estimated life nine years but actual durability is not really known.

(3) Conventional Writable Optical Discs; estimated life seven years, if stored properly.

I have known cheaper brands to not write at all and some failing to read in less than 30 days; good only to hang up on fruit trees to scare birds away. High-quality Optical Discs, such as Verbatim, are probably OK, and may last seven years, as estimated.

M-Disc is a new Optical Disc media, with a data storage life estimated by the manufacturer to be 1000 years,

as good as "Rune Stones". I recently found the web site of a company named MILLENNIATA based in Utah in the USA. www.m-disc.com will tell you all about M-Disc. Information is also available on Wikipedia.

Basically, M-Disc is made from inorganic materials, requires a special Optical Writing Drive but can be read on any high-quality Optical DVD Drive. Exhaustive tests have been made by various authorities in the USA, making the claim of 1000 years believable. I became seriously interested and tried to purchase some here in Australia but asking sales people in some of the larger computer shops about them just brought blank stares, as they had never heard about M-Disc.

By chance, I had to visit a local computer shop recently to sort out a serious problem with my wife's computer and spotted a couple of 10-packs of M-Discs. I asked the sales people about them and was told they were fairly expensive compared to normal DVD blanks. They said they had sold a couple of packs to customers but had them returned because they did not work.

Actually, the staff did not know what they were and neither did they know that a special drive with a much more powerful laser was required to write to M-Discs.

In the end, I purchased a 10-pack of M-Discs for $33.00 and an LG CN-12 Optical Drive for $69.00 from the shop and installed the drive on my computer. I found that everything works extremely well.

The M-Disc holds 4.7GB of data and can be written to at maximum 4x speed. They are manufactured in the Czech Republic and are somewhat different to normal DVDs, being slightly transparent and slightly heavier. After successfully writing data to one M-Disc, I decided to also write data to a normal Verbatim DVD and try some destructive testing on both, as follows:
(1) Drop the discs in water for five minutes, then dry them off using tissue paper. No problems.
(2) Leave the discs outside overnight, allowing them to be covered by condensation, then leave them in the sun to dry off. No problems.
(3) Leave the discs outside, including exposure to sunlight, for two days. No problems.
(4) Put the discs in boiling water for five minutes, then dry them off. No problems.
(5) Final destructive test – put them in a microwave oven. Both destroyed.

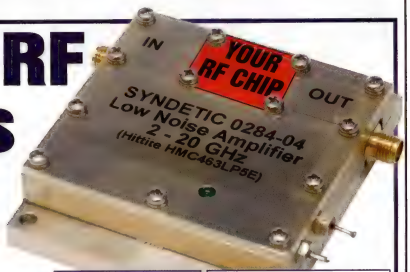
The Verbatim disc produced some spectacular fireworks; the metal layer blew up, creating sparks and flashes but the disc itself remained flat.

The M-Disc did not produce any fireworks but swelled up in places, suggesting that it does contain some conductive material. The disc itself also warped, suggesting that the surface may contain some conductive material.

To conclude, I am prepared to trust M-Disc for "long term digital storage".

Poul Kirk,
Perth, WA. SC

Custom RF Modules



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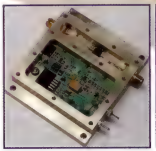

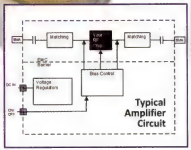

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Every now and then, something comes along that stops us in our tracks. Google Earth did when it first came out. Shipping AIS did it, too. Now there's another one: it's called ADS-B and via certain websites it lets you see, in real time, the location of every commercial aircraft flying anywhere in the world. That's right – anywhere in the world!

We're going to ask you to do something a little unusual before you start reading this article. We want you to go to your computer, go online and type in the URL **www.flightradar24.com** . . . and have a look (give it a few seconds to load).

Depending on the time of day, you're going to see, literally, thousands of aircraft in the air at once!

But even more interesting, if you click on a particular 'plane, you'll see it identified by carrier, type, callsign, origin and destination, eta, track, height, speed and much, much more.

Zoom in enough and you'll see the aircraft move towards its destination, in most cases right up to the point where it lands and taxis to its slot at the terminal.

Choose between a "map view" and a "satellite view" (the latter is much more interesting because it shows airport runways and taxiways).

You can also call up loads more data related to the screen you're viewing – the airports or origin and destination, for example. Or take a closer look at the type of 'plane.

Switch to "Cockpit View" and you'll get a pilot's-eye view as the plane flies along. Etcetera, etcetera, etcetera!

By Jim Rowe and Ross Tester

If that hasn't left you fascinated then we're sorry – your fascination quotient has obviously been used up.

For the rest of us, you'd have to agree that's pretty amazing. Being able to track aircraft from their point of departure to their point of landing in real time, with basically as much information about that flight as the air traffic controllers have, demonstrates the spectacular advances which have been made – and are still being made – in all facets of electronics.

What you're seeing is the end result of an aircraft information and identi-

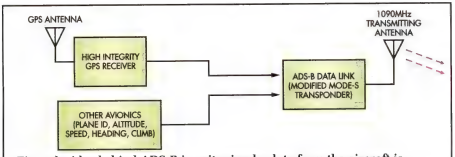


Fig.1: the idea behind ADS-B is quite simple: data from the aircraft is combined with accurate positional information and is transmitted to either satellite or ground receiving stations a couple of times each second. It's what happens to that data afterwards which makes ADS-B so valuable.

fication system called ADS-B, which stands for '**Automatic Dependent Surveillance – Broadcast**' and these words actually give you quite a few clues regarding what the system does:

'**Automatic**' means that the equipment in an aircraft requires no input from the pilot or external interrogation from either a ground-based secondary radar or another aircraft; it simply 'does its thing' automatically;

'**Dependent**' means that the system depends on being fed accurate position, altitude, speed, climb, heading and other navigation data from the aircraft's avionics system, along with the aircraft's ID information – again, all automatically;

'**Surveillance**' means that the system provides all of this information to any facility which requires this information, such as ATC (air traffic control) ground stations or other aircraft; and finally

'**Broadcast**' simply means that the information is continually broadcast from the aircraft, in the form of digital data bursts sent twice per second at a frequency of 1090MHz.

But what does all this mean?

In a nutshell, it means you get to see on your computer screen, in real time and from anywhere in the world there's a broadband connection, the same information an air traffic controller sees. And then some!

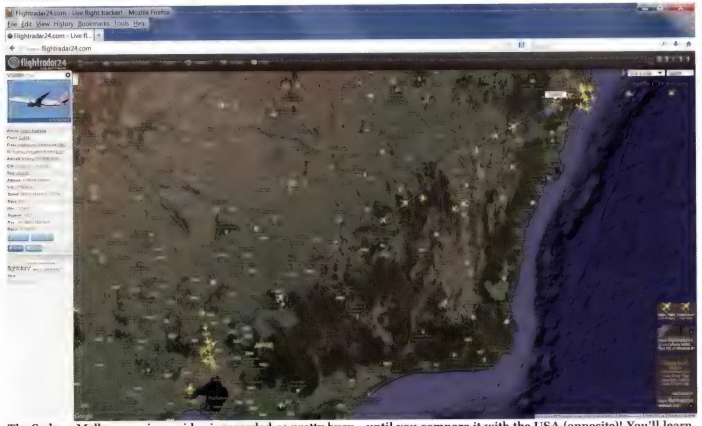
If all this is sounding vaguely familiar to you, we featured a somewhat similar idea back in our November 2008 issue. The big difference is for that system, you needed to buy a special AirNav Radar Box for just on a thousand dollars. Now, you don't have to spend a cent.

And in the ensuing five years, the amount of information accessible to you has increased dramatically.

"Off-air" version

You'll recall that we've been playing around with USB "TV" dongles over the past few months, putting them to uses their developers (probably!) never envisaged.

Well, we've found yet another use for them – as a receiver for ADS-B signals. We mentioned before that they are all on 1090MHz – well within the capabilities of many of these dongles. So elsewhere in this issue we show you how to "do it yourself" – with appropriate software you connect a suitable aerial which will cover 1GHz (eg, a discone) and away you go. But let's look a bit closer at ADS-B itself.



The Sydney-Melbourne air corridor is regarded as pretty busy – until you compare it with the USA (opposite)! You'll learn a lot from the flightradar24 website – even if you have never had any interest in aviation. And you'll waste hours on it . . . Since preparing this article, we note that flightradar24.com has updated its presentation – with even more information!

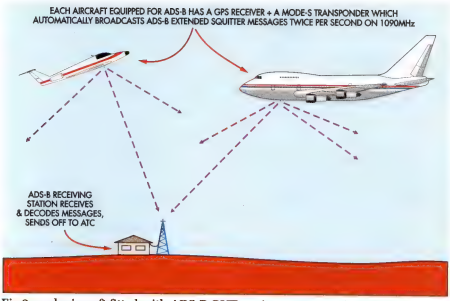


Fig.2: each aircraft fitted with ADS-B OUT equipment transmits ADS-B data 'squitters' twice a second, to be picked up by ground receiving stations.

Where it came from

The basic idea is pretty straightforward, as you can see from the explanatory diagrams of Figs.1&2, which show the basic elements of the ADS-B systems.

ADS-B had its origins in the aviation transponders developed during World War II by the military in Britain and the USA, initially as a key element in the IFF (Identification Friend or Foe) system used to differentiate between friendly and enemy aircraft. An IFF transponder in each aircraft would respond with the appropriate 'squawk' code when interrogated by another aircraft or ground station. (Today's trivia: the term 'squawk' seems to have arisen because IFF was originally code-named 'Parrot').

Further development occurred in the 1950s, when transponders were adapted to provide squawks with navigation information (like the aircraft's pressure altitude as well as its designated ID code) when aircraft were interrogated by so-called 'secondary surveillance radar' (SSR) or 'beacon radar' on the ground.

These so-called "Mode A" and "Mode C" transponders were used to provide traffic control services for general civil and commercial aviation. Primary radar at airfields was still used to determine an aircraft's range and bearing.

The next main development came in the late 1980s, when various tragic mid-air collisions between aircraft prompted the US Congress to pass a law mandating that all carrier aircraft operating in US airspace with more than 30 passenger seats would have to be equipped with equipment for TCAS II (Traffic Collision Avoidance System type 2) by 1993. Aircraft with between 10 and 30 seats were required to be fitted with equipment for a simpler TCAS I system.

This requirement resulted in the development of "Mode S" transponders, which were designed to provide the additional information for TCAS I and TCAS II when interrogated by either an SSR on the ground or another aircraft.

Mode S transponders provided information on the bearing of an aircraft, its altitude and its range from the interrogating transponder.

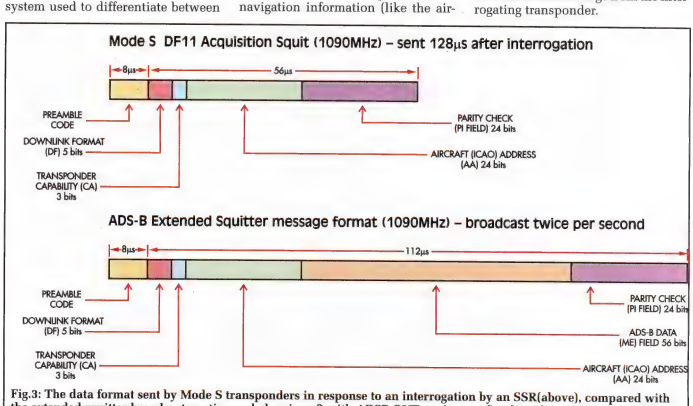
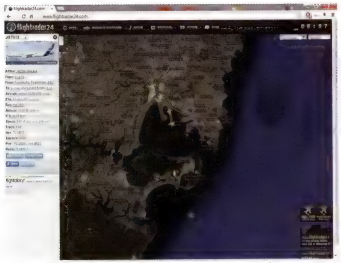


Fig.3: The data format sent by Mode S transponders in response to an interrogation by an SSR(above), compared with the extended squitter broadcast continuously by aircraft with ADSB OUT equipment fitted. Both are on 1090MHz but the ADS-B squitters carry more information.



Sydney International airport, mid-afternoon. There's one plane just landed on runway 34R, one on final approach to 34L and one to 34R along with another holding short on 34R, ready for its left turn to take off to the north.

One of the planes on final approach in the grab at left is an RAAF Canadair. Here's the "Cockpit View" option as it lands. With realistic instruments displayed, the software integrates with Google earth.

In order to provide this additional information, Mode S transponders were designed to transmit 64-bit 'squits' instead of the squawks transmitted by Mode A and Mode C transponders.

TCAS I allows a pilot to see the relative position and speed of all aircraft within a 10-20 mile (16-32km) range. In addition, it provides a collision warning when another aircraft comes too close. TCAS II expands on these provisions by adding information on whether nearby aircraft are climbing, descending or flying level. It also provides information on evasive manoeuvres necessary to avoid a collision. If both aircraft in danger of colliding are fitted with TCAS II equipment, their evasive manoeuvres are coordinated via an air-to-air link.

Enter ADS-B

ADS-B is essentially an improved version of TCAS technology which provides additional safety and reliability for both pilots and air traffic controllers.

It uses high-integrity GPS receivers in each aircraft to continuously monitor its exact position (latitude and longitude), plus a modified Mode S transponder which broadcasts this information automatically twice a second together with the aircraft's unique ICAO 24-bit Aircraft Address, the Flight Identification, the aircraft's barometric and geometric altitudes, the rate of climb or descent, the tracking angle (heading) and ground speed.

To provide this additional ADS-B data, Mode S transponders were modified to broadcast 120-bit 'Extended Squitter' bursts at 1090MHz. Fig.3 shows at the top the format of the Mode S 64-bit squits used for TCAS, with the format of the 120-bit extended squitter bursts broadcast by ADS-B Mode S transponders shown below for comparison.

Because this enhanced information is broadcast continuously at 1090MHz (rather than only in response to SSR interrogation), it can easily be picked up by ADS-B receiving stations on the ground, decoded and then relayed to ATC centres via either a satellite link or the internet. As a result ATC centres can monitor the position and movement of all aircraft fitted with ADS-B which are within range of the ground stations.

By the way, officially ADS-B is regarded as comprising two complementary aspects, known as ADSB OUT and ADS-B IN. ADS-B OUT is the aspect where each aircraft broadcasts its own ADS-B information, for surveillance mainly by ground stations. ADS-B IN is the complementary aspect where an aircraft can also receive the ADS-B broadcasts from other aircraft in its vicinity, so its pilot can be fully aware of their local environment. At present Australia seems to be requiring aircraft to be fitted only with ADS-B OUT, although many of the aircraft operated by international airlines are likely to be fitted with both.

One of the big advantages of ADS-B is that it allows monitoring of aircraft well outside the coverage of both primary and secondary radar. As a result the transition to ADS-B is seeing the gradual phasing out of ATC ground radar installations.

Another thing to note is that in the USA, the FAA (Federal Aviation Administration) has authorised two versions of ADS-B. In one version, called '1090ES ADS-B' the ADS-B extended squitters broadcast by each aircraft transponder are at 1090MHz, the frequency used in most other countries including Australia. In the second version, called UAT ADS-B, the ADS-B messages are broadcast at 978MHz using a Universal Access Transceiver (UAT).

The FAA intends that 1090ES ADS-B will be used by larger and faster aircraft operating at altitudes above 18,000ft, while UAT ADS-B will be used by all general aviation aircraft operating at lower altitudes. The idea of this separation is to alleviate 1090MHz congestion of the ADS-B system in areas where there is a great deal of air traffic. One comment we heard was that, looking at the USA on **flightradar24.com**, you wouldn't need to buy a ticket – you could walk across the USA wing to wing!

A further refinement in the USA is that, presumably for security and anti-terrorism reasons, the FAA has decreed that the information fed to the internet is delayed by five minutes.

And if you look at certain "trouble spot" areas of the world you'll probably find that ADS-B signals are either turned off as the aircraft approaches the airport or deliberately "mangled".

For example, at Ben Gurion airport in Tel Aviv planes simply "disappear" below about 8,000ft and at Dubai Airport, landing planes suddenly "take off" again in weird directions (ie, not using the runways!) at strange speeds.

Even here in Australia, we were tracking several aircraft landing at Cairns International when they too suddenly disappeared off screen – but the same aircraft landing at Sydney could be followed all the way down, along the taxiways and finally into its bay. We're sure there are other examples.

ADS-B in Australia

In our AirNav RadarBox story in 2008, ADS-B was already very well established locally. And in 2009, Australia became the first country in the world to be fully equipped for ADS-B coverage. At that stage there were 57 ADS-B ground stations, operating from 28 sites. These apparently offer complete coverage of the continent for aircraft flying above 20,000ft, with only small gaps between ground station coverage for aircraft flying across remote rural areas at lower altitudes. The coverage around each ground station is within 20 nautical miles on the ground, increasing to over 250 nautical miles at high altitudes.

According to Airservices Australia, all aircraft operating at FL290 (29,000ft) will need to be equipped with ADS-B OUT equipment by 12 December 2013. Then on 6 February 2014, all aircraft operating under IFR (Instrument Flight Rules) first registered in Australia after that date will need to be equipped with ADS-B OUT equipment.

By February 2017, all aircraft operating under IFR in Australia at all flight levels will need to equipped with ADS-B OUT equipment. (The above rules also apply to helicopters, if they are flown under IFR.) There are currently no requirements for recreational aircraft and other aircraft flown under VFR (visual flight rules) to be equipped for ADS-B, but from February 2014 any aircraft (IFR or VFR) imported to, or manufactured in Australia will be required to be fitted with a Mode S, ADS-B capable transponder - unless it will only be operating in 'Class G' airspace below 10,000ft.

Note that although ADS-B IN capability will not be mandatory in Australia under the current rules, there will still be a lot of incentive to fit it to aircraft voluntarily in addition to ADS-B OUT. That's because of the additional pilot information and hence improved safety.

North America and other countries

In the **USA**, ADS-B ground segment implementation and deployment for the complete National Airspace System (NAS) began in 2009 and was expected to be completed this year (2013). The complete system was expected to consist of 794 ground stations. The South Florida installation (involving 11 ground stations) was the first to be officially commissioned, although developmental systems have been online in Alaska, Arizona and along the East Coast since 2004.

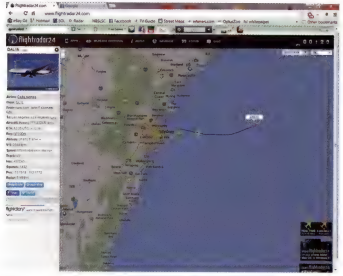
In **Canada**, ADS-B was implemented in 2009 to cover its northern airspace around Hudson Bay. The service is being extended to cover areas around the east coast of Canada and Greenland and is expected to be extended to cover the rest of the Canadian Arctic and the remainder of Canada in due course.

China had a fully functional UAT ADS-B system operating by March 2009, with eight ground stations spanning over 1200 nautical miles across Central China and over 350 aircraft fitted with UAT ADS-B equipment. Presumably this system has expanded considerably since then.

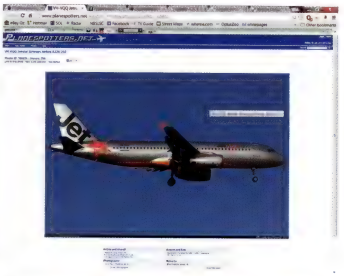
In 2010, 18 ADS-B ground stations began to be installed in **Iceland, Greenland** and **the Faroe Islands**, to extend ADS-B coverage across the North Atlantic Ocean.

The **European Community** is adopting ADS-B as part of its planned ATM Network, a unified Air Traffic Management system which will span across the EC countries. The EC is also combining ADS-B with what it calls Independent Surveillance, provided by either MSSR (Monopulse Secondary Surveillance Radar), Mode S (presumably TCAS) or WAM (Wide Area Multilateration). Many of the WAM system receivers incorporate ADS-B functionality.

WAM is already implemented in **Armenia, Austria, Czech Republic, Spain** and the **UK** (including the North



Here's an alternative "map view" showing 'planes over coastal NSW. If the image has printed clear enough, you might see that DAL16 is flying from JFK, New York, to LAX, Los Angeles. But it's just taken off from SYD, Sydney!



Click on a plane image in the left panel and it will take you to the www.planespotters.net website, with a large photo (and the photographer's details) and aircraft details underneath. Photo courtesy Planespotters, © Victor Pody.

Sea). The UK plans to have ADS-B plus WAM implemented throughout the country by 2018. In addition, WAM and ADS-B have been deployed in the larger cities in **Germany** (Frankfurt, Munich and Berlin), in **Portugal, Sweden, Bulgaria** and **Greece**.

ADS-B ground stations have also been deployed in **Cyprus, Italy, Norway** and the overseas territories of **France**.

So as you can see, ADS-B is growing rapidly around the world and looks very much to be the aircraft navigation and surveillance technology for the future - or at least the next decade or two, until something even better is developed.

Flightradar24.com

We mentioned this amazing website at the start of this article. It's been the cause of many a lost hour (oops, research!) following aircraft around the world.

But as well as the deliberate "fuzziness" in the system, there are gaps. That's because Flightradar24 relies on the altruism of individuals to receive ADS-B signals and relay them.

There are about 500 privately owned ADS-B ground station receivers around the world, all of which relay the decoded ADS-B information back to Flightradar24's server in Stockholm, Sweden via the internet. This allows the organisation to display all of the information on its website, in very close to real time – for monitoring free of charge by anyone, anywhere in the world.

But as you might imagine, only 500 ground stations (which are as simple as an antenna, an ADSB-receiver and a broadband connection) would leave significant gaps in many countries – Australia included.

When you look at Flightradar24 and note huge areas of, say, the African continent without a single plane, that's not necessarily because there are no planes flying – it's more likely that there are no ADS-B signals being received from that area. Flightradar24 covers about 90% of Europe and lesser amounts around the world.

At the time of going to press, Flightradar24 were looking for operators in many areas around the world and specifically mention Western Australia and the north-western part of NSW.

And they even offer free equipment (receiver and external S-mode plus external GPS antennas and all cables and software) to tempt operators in some areas. Obviously, you'd need a good broadband connection and a healthy data allowance because your equipment sends ADS-B data back to Flightradar24 continually.

As a reward, you also get access to Flightradar24 Premium (normally $2.99/month). As well as better displays, searches and filters, this allows you to use your Android or iPhone to identify an overhead flight simply by pointing its camera at it!

For more information, visit **www.flightradar24.com/free-ads-b-equipment**

We must admit, given the amazing number of aircraft being tracked in North America, that we were surprised that they were looking to fill so many on that continent. Perhaps it's the sheer volume that's beating them!

So if you want to volunteer to receive ADS-B data, away you go: just log onto the URL above.

But if you're like the rest of us, just be amazed at the service that is provided for you!

Tablets?

Yes, **flightradar24.com** is available for downloads on Android and iPads tablets – and the pro version gives you a lot more information for the really serious planespotter!

Anomalies?

The data is not perfect – there are often anomalies in the identification of aircraft, their track, etc. Just what was that plane travelling from Miami to Ft Worth (USA) doing over Cowra in central NSW? Or another travelling from Darwin to Denpasar heading south near Alice Springs?

No, we don't quite understand why either. Could it be the data has been scrambled between the receiver and flightradar24? Or could it be that the receiver for some ports is below the horizon when the 'planes get to a certain altitude.

We suspect that often only the origin and destination are fed into the system – intermediate ports don't rate a mention, except that the ETA is often that of those intermediate ports.

You will learn a lot – and question a lot. Like, for instance, why Jetstar and Qantas both have flights to the same destination (eg, Sydney-Melbourne) leaving within a few minutes of each other, when Jetstar is a Qantas subsidiary? (The same comments apply to Jetstar/Virgin – but they are in competition with each other).

Want sound too?

One other point: while not exactly part of flightradar24.com, you'll find your viewing pleasure greatly enhanced by listening to the tower at that airport.

We Googled "air traffic control Sydney" and came up with quite a few websites – for example, drill down into **www.liveatc.net** and you'll find many choices, such as Brisbane, Melbourne and Sydney centres, and in Sydney you can select North & East Approach, South & West Approach and Sydney Tower for runways 16L/34R and 16R/34L.

We clicked on one option and ended up with **www.bathurstscan.com/frequency-lists/sydney-air-traffic-control-frequencies-and-stream/** which was very interesting indeed!

It's one thing to see the 'plane suddenly turn right onto heading 350° – it's another to hear an air traffic controller tell that particular plane to turn right heading 350° – and then see it happen!

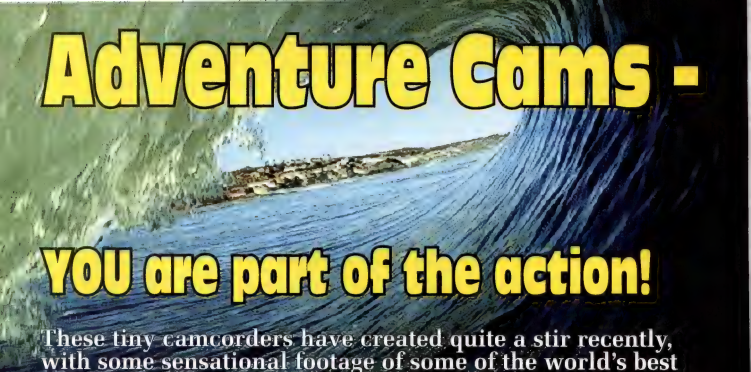
OK, so that's how ADS-B works and how you can view it on your computer. But what if you'd like to receive the actual ADS-B signal and display it?

If you'd like to build your own ADS-B receiver for next-to-nothing, see our article beginning on page 40. **sc**

Other sites

We have concentrated on the website **www.flightradar24.com**, but it is not the only website providing flgiht tracking services. There are many others, some similar, others more specialised in their application (eg, tracking specific flights). But they're all worth a look! Sites you could try (in no particular order!) include:

www.flightwise.com
www.planefinder.net
www.flightaware.com
www.webtrak.bksv.com
www.flightstats.com
www.radarvirtuel.com
www.flightview.com
www.flytecomm.com



Adventure Cams -

YOU are part of the action!

These tiny camcorders have created quite a stir recently, with some sensational footage of some of the world's best action sports. Here we take a look at the market leaders – where YOU can get up close and personal with the action!

You *must* have noticed quite a number of TV programs, especially extreme sports, which feature "action" sequences from positions which would either be impossible to film using traditional techniques or at the very least, would have posed great risk to life and limb.

Many programs, action sports in particular, feature amazingly detailed footage from "right inside" the action – more often than not you see exactly what the participant sees.

How do they do it?

Just as in most things electronic and photographic, great advances have been made in recent years. Miniaturisation has been the byword but that miniaturisation has not come at the expense of quality – in fact, the opposite is usually true.

If you're used to seeing "webcam" quality (at best VGA, usually a lot less!) look again – full HD (1080p) is now the norm with full broadcast quality almost passé!

I've seen a lot of these so-called "adventure cams" in recent times. But I still marvel at how "in your face" they can make the action and just how good the quality is!

Several months ago, I witnessed just such action first hand at the NSW Surf Lifesaving Championships, and the later two-night highlights program shown on Foxtel. I knew that a company had been contracted to put together the program and indeed, saw their "typical" (read large tripod-mounted!) video cameras in action.

It was only when it came to the "flags" event, where competitors race each other across 20m of sand and dive for lengths of rubber tube stood vertically in the sand, that I noticed the other cameras in their "arsenal"; tiny cameras, no bigger than a couple of cigarette packets.

There are a couple difficulties in filming flag competition. One is that sufficient clearance must be made between a fast-running then diving competitor and any film gear (it's common for stills photographers to use pretty long lenses for this reason). Another is that in that dive and mad scramble for flags, sand literally goes everywhere. Pity help a ten or twenty thousand dollar professional video camera that's within range (salty sand and precision optics do not make good bedfellows).

Then there were all of the water events – surf swimming, boards, skis and the perennial surf boats. Practice in the past has been to put the camera in a waterproof case (even more size and weight) and place the cameraman in a rubber duck (IRB) or on the back of a jet ski.

by Ross Tester

At these championships, they went one better – the tiny cameras were in waterproof housings all right but these were secured to the front and rear of the boards, skis and boats in the competition, or fastened to the helmet of the sweep in a row boat (for example). Others were actually held in the hand by cameramen swimming with the competitors for some sensational water-level and indeed underwater action.

Of course, surf lifesaving is not the only area where video action is captured in this way. Yachties love 'em, because a tiny camera secured to the mast (or elsewhere) isn't going to affect the yacht's performance but will still get some memorable footage (what is the right word in the digital age?)! Think Sydney-to-Hobart or Olympic Yachting and you'll probably remember some.

Mountain biking, surfboard riding, snow skiing and snowboarding, scuba diving, kayaking, even skateboarding... just some of the sports where some amazing footage has been taken. It's also used extensively in advertising, on board aircraft, racing cars and bikes

– in fact, anywhere you can strap on or clip on a camera!

The media used in the camera (or more accurately camcorder) is normally a microSD card.

Go-Pro

By far the largest share of this "sports action" video camera market belongs to a company called GoPro. They've been the innovators in this area and have certainly earned "the name".

To prove what I've been saying about the quality of the video shot by GoPro gear, even if you never intend to buy one, have a look at the GoPro website and take a look at their opening page video. And be gobsmacked!

In fact, it was GoPro gear that I was referring to above at the SLS NSW Championships.

There is a range of cameras in their latest "Hero3" edition, from their 5MP "White Edition" featuring 1080p @ 30 fps (frames per second), through the 11MP "Silver Edition" (also 1080p @ 30 fps) up to the latest and greatest 12MP "Black Edition" which does 1080p @ 60 fps – ie, virtual broadcast quality, especially with a bit of post-production!

They're sold just about everywhere these days from sporting stores and outdoor stores to many photographic stores and even some department stores, with prices of the three models ranging from about $269 to $489, depending where you buy.

The earlier, similar "Hero2" models are still available in many stores – in fact, you have to be a bit careful that you're being sold the model you want.

Apart from the camera itself, the thing that sets GoPro apart from its competition is the huge range of accessories available.

Some of these are "necessaries" rather than accessories so you need to factor them in before you slap down your plastic.

We were so impressed with the GoPro that, after many "dead end" phone calls we finally tracked down an Australian distributor who said that they would be happy to supply one for review.

And we waited. And waited. And ...

GoPro's Hero3 series is by far the market leader with a well-earned reputation. Shown here is the "Silver" model, middle-of-the-road in both features and price.

Here's the Contour +2 inside its waterproof case. While many sports don't require immersion, the case gives a lot of protection from inevitable splashes.

Much ligher and cheaper is Sony's Action Cam. Picture quality might not be up there with the big boys but it's still certainly worth another look!

So we would have liked to bring you a "hands on" report on the GoPro Hero3 but we'll have to limit ourselves to the observations already made.

Contour +2

This is a rather different beast from the GoPro but from reports we've heard, is gaining a very healthy reputation.

The main thing that sets it apart is its built-in GPS (so you not only know what you've seen but where you've seen it!), a rotatable lens, a laser-sight level and the ability to mount it without putting it in its waterproof case. That case, by the way, gets you down to 60m.

It's no lightweight at 155g but it can shoot 1080p @ 30 fps right through to 480p @ 120 fps.

Battery life, too is a possible game-changer – we've heard reports of 4 hours of life in the Contour +2, versus ~1 hour (or less) for the GoPro Hero3 Black. Its low-light performance is supposed to be right up there.

The Contour +2 is also controllable from your iPad or Android smartphone. In fact, to access most settings you'll need to pair it with your phone or connect it to your computer.

Price-wise, there's not a lot to choose from between the GoPro Hero3 Black and the Contour +2, at least as far as Australian street prices go. But shop around!

Sony Action Cam

For those looking for a much lighter action cam, you might look at the 55g Sony Action Cam.

According to most reports I've heard, its video quality is not quite up to other action cams on the market (when compared A:B) but in isolation, you'd probably be pretty happy with it. However, it's the only one that offers image stabilisation (called Steady Shot) and is the easiest to point and shoot.

The Action Cam starter pack represents pretty good value at $299 (RRP) and there are many, many accessories available for it.

Sony Australia (www.sony.com.au) are the importers but both the Action Cam and Contour +2 are available just about everywhere!

Ion Air Pro Plus

One you may not have heard of is the Ion Air Pro Plus. It's distributed by CR Kennedy in Melbourne (www.crkennedy.com.au). It's one of the lighter action cams at just over 120g and is waterproof "as it comes" to a depth of 10m, so no separate casing is needed. It also comes with a waterproof microphone so you can dive with the whales and record their discomfort at having you in their domain. It's claimed to have a super-low-light sensitivity of >1.4 V/lux-sec.

It also features 1080p (HD) 30 fps video and 5MP stills – these can be sequenced in three per second or one every 10, 20 and 30 seconds to create "step photo" video.

The microSD card can be up to 32GB and on this you could fit up to about 250 minutes of 1080p video. Battery life is a bit limited at 2.5 hours.

Altronics HD Action Cam

Altronics Distributors (Perth, Melbourne and Sydney) have this lightweight (24g) camera which offers 1920 x 1080HD or 848x480DI resolution but also has a low-resolution mode to extend recording time. The 450mAh Li-Ion battery gives up to two hours recording.

It comes with a waterproof case (rated to 20m) and a range of mounting accessories, including helmet strap, bar mount and neck hanging strap, all of which can be used with or without the case. It offers full HD (HDMI 1080i) resolution in movie mode and can also shoot stills at up to 3200 x 2400. With just 1 lux minimum illuminaton it can handle dark scenes with ease. It's just 30 x 52 x 26mm and weighs in at around 24g. www.altronics.com.au; tel 1300 797 007.

Drift HD Ghost

Another one that hasn't received the rave reviews of the GoPro but is nevertheless attracting a lot of attention is the Drift HD Ghost. It's quite a different beast to look at and it's quite a different beast in operation.

It shoots 1080p like the rest and it sports a 170° wide-angle rotating lens – mount the camera on whatever angle and the lens rotates itself to ensure the perfect horizon/angle. It's waterproof to 3m without an optional housing. (There is an optional housing which goes down to 60m if you want it).

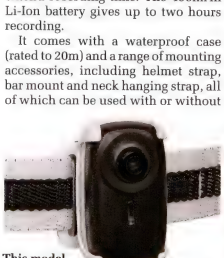
With built-in WiFi it can communicate instantly with smartphones, while the battery life is claimed to be the longest on the market, at 3 hours.

Included with the Ghost is a two-way remote control, a spare rear connector hatch, USB cable, 3.5mm mic extension cable, accessory travel case, 1700mAh battery and three mounts: a goggle mount plus one curved and one flat adhesive surface mount. Recommended retail in Australia is $459.00 Camzilla in Sydney (02) 9880 9883 (www.camzilla.com.au) is the only Australian retail showroom dedicated to action cams (including the Drift) and will be glad to advise you on the best suited camera for your purpose.

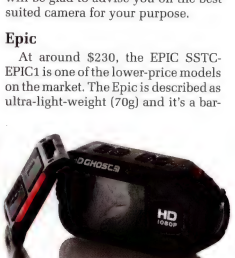
Epic

At around $230, the EPIC SSTC-EPIC1 is one of the lower-price models on the market. The Epic is described as ultra-light-weight (70g) and it's a bar-

The barrel-shaped Ion Air Pro Plus is waterproof to 10m without the need for an external case. It features 1080p resolution and inbuilt WiFi.



This model from Altronics includes a selection of mounting accessories including helmet strap, bar mount and neck hanging strap all of which may be used with the waterproof casing.



The Drift HD Ghost certainly looks the part. I'm not sure about the 170° field – it makes everything look a bit "fish-eye-y". But it's a neat package!

rel shape which measures only 75mm long. It too will shoot up to 30 frames per second with up to 100 minutes of video on a 4GB card.

We don't know of anyone with an Epic, nor have we found an Australian distributor – though there are several retailers that pop up on good ol' Google – LeGear (Gold Coast) and Sportscamera (Sydney) for example.

Navig8r NavsportPro

We didn't know much about this brand, apparently from the same people who bring you the Navig8r GPS units (among other things), until we spotted an advert for it in a Target Toy Sale flier, of all things.

The thing that attracted our attention was the price – just $59 (reduced from $99) – but then we noticed that this was for a 720p model so it doesn't really compare with the others shown here. There is a second 720p "Mini" sports camera on their website selling for $69.95 but it is marked as "not available" at the moment.

But further investigation showed that Navig8r (part of the Laser Corporation, an Australian company) do indeed have a 1080p model (60 fps) with a housing claimed to be waterproof down to 100m, a wireless remote control, an additional battery pack and an assortment of "premium mounting accessories".

One nifty feature of the Navig8R NavSportPro is a built-in laser pointer so you can aim the camera exactly when it is mounted, for example, on your helmet.

The Pro model (shown below) is priced at $299.95.

Incidentally, Laser Corp also have a range of in-car event and accident recorders including (as you might expect from this company!) GPS tracking.

Further details from the Laser website, www.laserco.net/products/gps/navig8r-sports-camera

And then along came Jaycar!

Purely by coincidence (honestly!) while we were waiting for GoPro to get back to us, the manager of our local Jaycar emporium (knowing my interest in photography) told me about the new action camcorder they were stocking (thanks, Zig!).

A call to Jaycar's marketing manager soon had a sample on its way to us for a review.

So while this feature is about several of the sports/action/adventure camcorders available in Australia we will concentrate on the Jaycar 1080p HD Sports Camera (cat no QC8020).

Jaycar's HD Sports Cam is the cheapest 1080p on the market yet offers at least as good facilities as most, and more accessories than most! The remote control and waterproof case are included.

The most noticeable feature, even before you open the box, is the price. At $169 it's significantly cheaper than most of the other action cams sold in Australia. The "gun" price in Australia for the GoPro Hero3 White, which the Jaycar is very close to in specs, appears to be about $230 – but ranges up to about $300 or so. And that's the naked camera – if you want any accessories, you need to add them on.

The Jaycar sports cam comes with a fully waterproof case, a handlebar mount, glass suction mount, helmet mount and a surfboard mount, along with an infrared remote control. That's a pretty impressive list to be included in that $169!

Then there's the EPIC – one of the lower-priced models on the market.

And finally, the Navig8r Sports Cam Pro, in its 100m-rated waterproof case.

OK, so what are its specs?

As we said, it comes pretty close to the GoPro Hero3 White: 5.0MP resolution, f/3.1 2.9mm lens with 120° angle, a 4x digital zoom and can shoot at three resolutions – 640 x 480 (VGA) @ 120 fps, 720p (1280 x 720) @ 60 fps and 1080p HD (1920 x 1080) @ 30 fps. In still image mode you can get up to a 12MP (4000 x 3000) image and the built-in microphone adds sound if you want it.

With up to a 32GB microSD card, you can store up to 192 minutes of video; however the drawback here is the limited (1 hour) battery life.

Weight is a very respectable 50g and size of the camera (out of the waterproof case) is 74(l) x 52(w) x 30(d)mm.

So as you can see, it's not dissimilar to the other action cams we've listed above. Of course, it won't match the performance of the GoPro Hero3 Black – then again, none of the others will either – but you'll pay the best part of

OK, so the front of the Jaycar Action Cam is pretty bland – but then again, given the usage of the device and minimal user controls, why wouldn't it be?

Almost the whole of the rear of the cam is this 2.4-in colour touch screen which doubles as a menu selection device.

$500 for one of those from an Australian retailer. There are better deals from some stores who sell overseas-sourced models but questions are then raised about warranties and so on.

Controls

There are only three instantly accessible controls: power, shoot and display on/off (to save power). And when inside the waterproof case you only get the first two. Arguably, that's all you need – especially when in an action environment.

The infrared remote, which of course works through the waterproof case, has power, snap (ie still photo) and video buttons.

Attachment to the camera is via a standard 1/4-in thread so as well as using any of its mounts, it will fit on a standard photographic tripod thread.

A rubber cover on one side lifts to reveal the microSD card slot (it will handle up to 32GB, though this needs to be a class 10 for optimal performance – class 4 cards will give error messages).

On the opposite side is another rubber cover which hides the standard mini-USB socket (used for both charging and connection) and an HDMI socket for connecting your HDMI TV.

The back of the cam is, with the exception of the display on/off switch, taken up almost completely by the 2.4-inch colour touchscreen display.

This shows real-time images along with settings for date/time, mode (video/still), resolution (FHD [30 fps], HD [30 fps], HD [60 fps] and VGA [120 fps], + and – (for zoom) and elapsed time (ie, amount of video stored) in h:m:s.

In use

With only two buttons, even the most non-technical person should be able to figure this one out – power it up and press the "go" button to start recording. Oh yeah, you have to press the "go" button to stop it again.

Even the display-driven controls are pretty-much self explanatory.

So how did it go?

Well, I have to admit that, being the middle of winter and in a particularly nasty week of weather in Sydney, I didn't exactly take it underwater. However, I did try it mounted in the car and it behaved exactly as I expected it to.

Incidentally, that's been a somewhat unexpected application for a lot of action cams: vehicle recorders. It's become quite popular for owners to put them in their cars when not using them as "nature" intended, thereby keeping a video of their car and those around them. Very handy for road rage incidents and accident insurance claims, I'm told!

My son and heir, who is a lot more athletic than I, volunteered to take it skiing and get some real action video (well, in his case, probably more upside-down-in-the-snow video!). He did, and he did . . . and no, I wouldn't let him keep it. While the snowboarding videos Craig took were tame by comparison to the off-the-side-of-the-mountain footage on the GoPro site, they're nevertheless quite impressive and demonstrate the potential of this remarkable little camera.

OK, in a nutshell? Impressive. And at the price, it's a bargain, especially compared to the big name models.

Please note: the only action cam we were able to actually use was the Jaycar model (even though we've tried out a GoPro Hero2 Silver in the past). All other information came from the various company literature and/or websites. SC

Does your design need advanced analog integration with 3V or 5V operation?

Low power, low cost, low pin-count microcontrollers from Microchip

New PIC24 "KM" MCUs combine on-chip op amps, 8-bit DACs, 12-bit ADC, flexible PWM modules and power-saving features with 3V or 5V operation and low pin-count packages for cost-sensitive applications.

Microchip's PIC24 "KM" microcontrollers are the first to integrate the new Multiple-output Capture Compare PWM (MCCP) and Single-output Capture Compare PWM (SCCP) peripheral modules, with a Configurable Logic Cell (CLC) for enhanced on-chip peripheral interconnectivity.

The MCCP and SCCP modules enhance design flexibility by combining timers, input captures, output compare and PWM functions in a single time-base. They also feature 16/32-bit support and can automate operations during sleep mode to enable optimization of power consumption.

A choice of 3V or 5V operation delivers greater flexibility to match performance to different applications: The 5V PIC24FV16 "KM" family combines power-saving features with enhanced dynamic range, noise immunity and robustness; whilst the 3V PIC24F "KM" family adds eXtreme Low Power (XLP) technology to extend battery life in handheld applications.

DEVELOPMENT TOOLS:

3V PIC24F "KM" DM240013-1 Microstick

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Test Gear Review . . .

The Digitech QM1577 is supplied with an attactive carry case, plugpack charger, probes and an optically-isolated USB interface cable.

Tiny Scope Shootout

By NICHOLAS VINEN

Digital Storage Oscilloscopes (DSOs) have come down substantially in price while being greatly improved in terms of features. But they are still fairly bulky. What about when you are in the field, away from power and need something much more portable? We decided to have a look at two tiny alternatives: a credit card-sized scope from Seeed Studio and a combined DMM/scope from Jaycar.

(1) Digitech QM-1577 ScopeMeter

THE DIGITECH QM-1577 10MHz DSO/4000 Count True RMS DMM from Jaycar is a fully-fledged DSO that you can hold in one hand. While a bit larger than a typical DMM, it does a good job of combining a single-channel scope and True RMS multimeter into a small, portable package.

It has a 128 x 128 pixel monochrome liquid crystal display (LCD) with a backlight that can be switched on and off, giving decent contrast indoors and outdoors. The screen can be viewed without a backlight indoors as long as there is a reasonable amount of available light and this will extend the battery life. The battery is rechargeable; a plugpack is supplied.

Battery life is not stated but it seems to be at least a couple of hours of continuous use in DSO mode and presumably longer in DMM mode. There is an auto-off function which shuts it down after a few minutes from any mode if no keys have been pressed, to conserve the battery.

The unit measures 186 x 86 x 32mm and has a built-in desk stand. The rubbery blue plastic surround appears to be removable but not easily so.

Scope mode

The critical statistics in scope mode are: 10MHz analog bandwidth, 50MHz sampling rate, sensitivity of 50mV/div to 200V/div and 8 bits of vertical resolution (which is typical). Rising and falling edge triggers are available and input impedance is 10MΩ. A standard probe is not supplied with the unit. Instead, you simply use the standard DMM probes and since it has

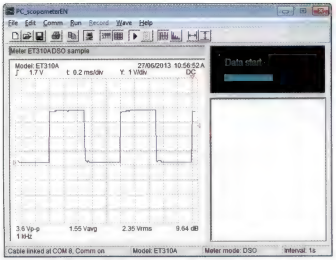


Fig.1: the QM1577 operating in scope mode via an isolated USB connection to the PC. This can be used to record a series of captured waveforms and play them back later. It also has an FFT mode, which is only available when using the PC software.

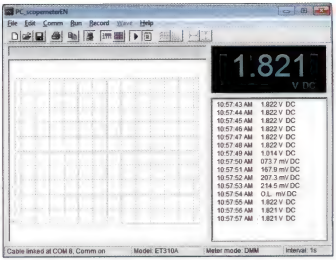


Fig.2: the QM1577 can also be used in DMM mode in conjunction with the PC software. It can then be used as a data logger in any of its measurement modes (voltage, current, etc). Measurements are shown as they are logged and can then be saved to disk.

banana sockets, you can get plenty of accessory leads such as alligator clips and so on.

The scope mode works surprisingly well for such a small instrument. While the feature list is relatively sparse, it certainly meets its specifications and the display is essentially noise-free. It gives a good solid trigger lock well beyond 10MHz (albeit with reduced signal amplitude, as you would expect). The actual analog bandwidth appears to be around 20MHz although by that point, the 50MS/s sampling rate becomes the limiting factor.

The update rate is pretty good, with several screen refreshes per second at the faster timebases. The interface is responsive and the delay between the signal changing and this becoming visible on the screen is pretty low – a fraction of a second. It has a bit of a "phosphor" effect due to the time taken for pixels to "fade out" as they are turned off but that isn't necessarily a bad thing.

You can adjust the following: input coupling (AC/DC/ground), timebase (50ns/div to 20s/div in 1-2-5 steps), trigger time offset (across the width of the screen), vertical sensitivity (50mV/div to 200V/div, in 1-2-5 steps), vertical offset, trigger type (rising/falling edge), trigger voltage and trigger mode (auto, normal or one-shot). These adjustments are made primarily using the F1-F4 soft buttons below the LCD.

As you can see from the photo, the trace occupies most but not all of the display – it's about 120 x 96 pixels with about 12 pixels per division (10 x 8 divisions). This gives a decent view of most typical waveforms. The "HOLD" button freezes the display and you can then save it to one of 100 internal memory slots by holding this button down for a couple of seconds. Waveforms can be reviewed at any time via the MEM button and measurements can be made on them using horizontal and vertical cursors.

The signal amplitude and frequency are permanently shown below the graticule with frequency in Hz/kHz/MHz (auto-ranging) and amplitude as one of Volts (peak-to-peak) Volts (average), Volts (RMS), dB (dBu, we're guessing). Pressing the FUNCS button cycles through these options.

There is also an AUTO RANGE button which is very useful and this sets up the timebase, vertical sensitivity and so on, to suit the waveform you are probing. Of course, you can always do this yourself but most of the time AUTO RANGE will do a reasonable job so you might as well let it.

DMM mode

In multimeter mode, the QM-1577 has all the basic functions you would expect for a True RMS multimeter. That includes voltage (DC/AC), current (DC/AC) with both 400mA and 20A ranges, resistance, diode test, continuity (with buzzer), capacitance, frequency, duty cycle, and temperature/h_{FE}/clamp meter modes which require probe adaptors to function.

It's an auto-ranging Cat III meter rated for up to 1000V. Accuracy and precision are typical for a 4000-count meter, however a few modes available in other meters are not present such as low current (microamps) – resolution in mA mode is 10µA. Rather than change modes with a rotary switch, you cycle through them by pressing the FUNCS button.

In most of the modes, you can make relative measurements (ie, zero the reading) and it can also do peak-hold for both minimum and maximum measurements while displaying the currently measured value. These extra functions are accessed via the F1-F4 soft buttons.

The drawback of DMM mode is that it's only a 4000-count meter. Dedicated DMMs of this size and cost usually have an extra digit of resolution. One big advantage though is that with that large dot-matrix display, the read-out is neat and it can show you a lot of information simultaneously. For example, for voltage measurements in peak-hold mode, you can simultaneously see the reading, the mode (DC/AC), the range and the current minimum and maximum values.

In fact, in every mode and range, the maximum possible reading is shown in the upper-left corner of the screen and this provides you with a quick indication of whether it's likely to change ranges automatically, depending on what you are measuring.

You also get some extra information in some modes – for example, in resistance mode, you can also get the

The Seeed Studios DSO Nano V3 is much smaller than the Digitech ScopeMeter and fits easily into a shirt pocket. It's shown here only slightly smaller than actual size.

(2) Seeed Studios DSO Nano V3

THE DSO NANO is a much smaller single-channel portable DSO. It fits in a shirt pocket (92 x 60 x 13mm) and doesn't have any DMM features other than frequency and amplitude measurement of the input signal but it has a square wave signal generator output.

The Nano has a 320x240 pixel colour TFT screen which measures 7cm diagonally. It's housed in a black anodised aluminium case and has just a few controls: five pushbuttons on the front, two on the top and a power switch on the right. On the left side are the probe input and signal generator output sockets (both 3.5mm phono types) and a USB socket for charging the internal Li-Po battery.

Two types of probes are supplied, both about 55cm long. One has black and white mini hooks, which are handy for clipping onto component leads (probably more so than the traditional type of oscilloscope probe) and the other is terminated in two small pins which can be pushed into a breadboard.

Depending on what you are trying to monitor, the probe leads are a bit short and you need to tether the Nano so that it is not pulled around, making it awkard to view. It does come with a small aluminium desk stand and we would be inclined to attach that to a small piece of timber, to give it some more mass. Also supplied is a vinyl protective case and a couple of small stick-on rubber feet.

No USB cable is supplied but all you need is a standard mini USB (not micro) cable and it can be charged from a computer or mains/vehicle power with an appropriate adaptor.

Specifications

The specifications for the DSO Nano are modest, with an analog bandwidth of 200kHz and a sampling rate of 1MS/s, although vertical resolution is good at 12 bits. Maximum input voltage is 80V peak-to-peak and input impedance is around 0.5MΩ. The square-wave generator has a frequency range of 10Hz to 1MHz in 1-2-5 steps

Digitech QM-577 ScopeMeter – continued

conductance (the inverse of resistance, measured in Siemens) read-out below the resistance display. What you are reading (voltage, current, etc) is indicated at the top of the screen so there's never any doubt.

Windows software

The QM-1577 has a USB port and can be connected to a computer, either for data logging or to use the features of the scope/DMM remotely. The supplied cable is optically isolated for safety however it still plugs into a socket on the unit, rather than using a purely optical interface via a transparent window like many other meters. That means you need to keep the protective cover closed when not using the USB interface, to prevent dirt and moisture from getting in.

Also, being isolated, the internal battery is not charged when plugged into a computer so you are limited to a few hours of such use, by which time you will need to unplug the computer and plug in the charger instead.

The supplied software is Windows-only. It works in Windows 7 but you need to enable XP compatibility mode and download the latest CP2102 USB-to-serial adaptor driver from the SiLabs website. This software allows for real-time operation of the scope (Fig.1) and/or multimeter (Fig.2) via on-screen displays which more or less mimic those on the unit itself, plus scope waveform recording, spectrum analysis and multimeter data logging features.

Conclusion

The QM-1577 is supplied with a carry case (quite a nice one), mains charger (plugpack) with USB plug, optically isolated USB interface cable, driver/software CD and a pair of standard DMM probes. The only documentation on the CD is for the PC software but the unit is pretty easy to figure out.

It is a good all-round portable instrument that is easy to carry and use and provides a range of very useful functions. Its recommended retail price is $399.

The unit is available from Jaycar stores or by mail order via their website – see www.jaycar.com.au or www.jaycar.co.nz SC

and a fixed amplitude of about 3.3V peak-to-peak.

If you're thinking that those features sound a lot like what's available on a microcontroller, you'd be right as the DSO Nano is based on an ARM Cortex M3 processor with its 1MS/s ADC forming the crux of the input system.

The colour display is clear and crisp when viewed front-on or at moderate vertical offsets. The software features cursor support, adjustable trigger sensitivity, a single measurement display (frequency, RMS voltage, peak-to-peak voltage, duty cycle or average voltage) and multiple trigger modes including one which automatically adjusts the timebase and vertical sensitivity to suit the signal.

We found that with noisy signals, the triggering was rather fussy, with the signal jumping around even when the trigger sensitivity was set at minimum. This possibly indicates a lack of dedicated trigger hardware, ie, the software likely monitors the ADC to determine when to start sampling rather than using a dedicated comparator circuit.

The DSO Nano has a vertical sensitivity range of 10mV/div to 10V/div and a timebase adjustment range of 1µs to 10s in 1-2-5 steps, although the faster timebases are not very useful given that 1MS/s equates to one sample per division at the fastest setting (1µs/div). There is no option for AC input coupling; you would need to connect a capacitor in series with the probe to achieve this.

The Nano we bought has a microSD card slot for storing waveforms but we couldn't get it to work with the 16GB cards we had on hand; perhaps the capacity was too high. The latest version, though, has 2MB of built-in flash memory for this purpose instead and we presume screen grabs stored in this memory can then be downloaded later via the USB port.

The internal battery is also charged over USB. Its capacity is 500mAh @ 3.7V (nominal) which gives a life of about one hour of continuous use.

If and when a new version of the firmware becomes available, you can update it via USB. We noted a few minor bugs in the version that came with our unit (stray pixels left behind on screen under some circumstances) so this should come in handy.

Note that there are also third-party firmware images available which have certain advantages over the official firmware (which is supplied with the unit), so this gives further upgrade options. But we also noticed that the PDF manual refers to a different set of features than is available on the unit we purchased, presumably because it was written for a different firmware version.

Overall, this is a very basic scope in a convenient package. It's pretty easy to use although it takes a few minutes to figure out the rather terse on-screen descriptions. The big advantage though, besides portability, is the price. It's available from the Seeed Studios website for US$90 including airmail postage from Hong Kong. Delivery time is typically 1-2 weeks.

The unit is also available locally from **www.soundlabsgroup.com.au**

We should point out that Seeed Studios also sell the DSO Quad for $169-$199 which is much more capable and slightly larger. It's 98 x 60 x 14.5mm but has two analog channels with 10MHz bandwidth which run at 36/72MSps (8-bit vertical resolution) plus two digital channels. The $169 version comes in a plastic case while the $199 version has an aluminium case. SC

Bird song - without the mess!

Ever wished you could have beautiful bird song in your home, without having to own a live caged bird? With PCBirdies, you can have the luxury of not one, but two singing birds. You won't have to buy a cage or even bird seed. . . and best of all, there's no mess to clean up!

It can be very calming and relaxing to have bird song in your home. In fact, when people have heard this project, without knowing the technicalities, they have found it charming.

PCBirdies will sing from time to time, at random intervals so it (they?) can pipe up unexpectedly at any time during the day, which can be a pleasant diversion. You can hear a few samples of its song on our website.

PCBirdies is (are?) housed in a small plastic box. This might sound a bit cruel but it is entirely happy to be there and we can assure concerned readers that no birds were harmed or put under stress during the development of this project. In fact, as the proverb states, "A bird in the hand is worth two in the bush".

Inside the box are two piezo transducers that produce sounds which simulate those of two separate birds. So it might be said that PCBirdies is better than two in the hand.

PCBirdies is powered from a 3V lithium button cell and employs two microcontrollers, each one driving its own piezo transducer.

Arguably PCBirdies sounds similar to a canary but it we should state at the outset that a typical canary's song is more varied and they typically sing for much longer periods (their songs can last up to several minutes at a time).

But then again, they may go for hours or days without singing at all. PCBirdies, on the other hand, can be guaranteed to sing for your pleasure many times during the day, at seemingly random intervals.

Canary songs consist of a series of chirps, tweets, trills and warbles and they seldom repeat the same sequence twice. PCBirdies' songs also consists of chirps, tweets, trills and warbles but its songs are much shorter, typically lasting for about eight seconds.

PCBirdies gives the option to change the canary sound from one type to another. (Try doing that with a real bird). Each selection imitates typical canary sound phrases. Song A is a typical canary and Song B simulates a Fife canary. Song C is a selection that comprises various single phrases of these birds. The fourth selection comprises a medley of all the above played over time.

PCBirdies sings at random. Each song is repeated between two and

Specifications

Power: 3V from a CR2032 lithium cell
Current: 0μA when switched off,
1.8μA per IC during periods of silence
735μA per IC while chirping
Sounds: Selection 1 – typical canary sound
Selection 2 – Fife Canary
Selection 3 – various individual phrases
Selection 4 – medley of the first three.

By JOHN CLARKE

PCBirdies is fully self-contained in a small zippy box. It will only burst into song in daylight – at night, like any good canary, he (it? they?) goes sound asleep!

27 times with a 2.4 to 17-second gap between them. There is an extended gap between each series of repeated songs and this is between 80 seconds and 9 minutes.

PCBirdies only sings during daylight or under artificial light - an LDR (light dependent resistor) senses the ambient light level.

The "birds" sing in and out of unison to simulate two separate birds. The two birds are re-synchronised at the end of a darkness period and also at the end of the extended gap period.

Note that PCBirdies does not simply play sampled segments of real canary songs. Rather it simulates the bird song by varying the frequency, volume and length of bursts of pulse trains applied to the piezo.

The volume is adjusted by changing the pulse width of signals applied to the piezo transducers. Narrow pulses give low volume while wider pulses give more volume. Maximum pulse width equates to a pulse duty cycle of 50%.

Each chirp starts with a minimum pulse width, increasing to the required volume level over time. Similarly when a chirp or tweet is about to end, the pulse width is reduced to zero over a short interval. This has been done to avoid any clicks from the piezo transducers which would otherwise spoil the effect.

Circuit details

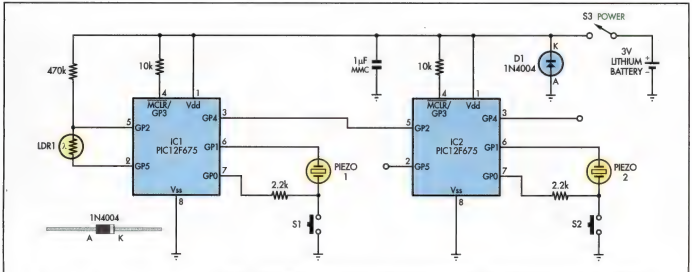
Fig.1 shows the circuit and it is quite simple, comprising two identical microcontrollers with both using same software; one microcontroller acts as master and the other behaves as the slave. Power comes from a single 3V lithium button cell.

IC1 is the master microcontroller and this has an LDR connected between its GP2 and GP5 inputs, to monitor the ambient light. To do this, the GP5 output, pin 5, goes low momentarily to connect the LDR and 470kΩ resistor in series between the +3V supply and 0V, via GP5.

When light is present, the LDR has a low resistance and so the GP2 input will be low; close to 0V. In darkness, the LDR's resistance is high and GP2 will be high; close to +3V. The voltage level at GP2 is duplicated at the GP4 output which connects to the GP2 input of IC2. So when IC1 "sings", so does IC2.

But the GP4 output of IC1 is used more effectively than just following the LDR light level measurement. By taking advantage of the fact that the bird sound is not produced in darkness, the GP4 output of IC1 is also used to help IC2 resynchronise with IC1.

During longer phases of no output sound from IC1, the GP4 output is taken high. This sets IC2 to sense darkness and its timer that determines the gaps between bird songs is reset.



SC ©2013 **'PC BIRDIES'**

Fig.1: not much to it, is there! Basically, it's two microprocessors driving two piezo transducers. The bird songs can be altered by pressing S1 and/or S2.

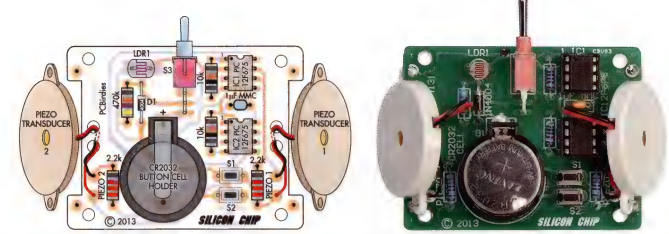


Fig.2: the component overlay for the PCB with a matching photo alongside. The piezo transducers are secured to the PCB, as described in the text, and the whole assembly pops into a UB5 box.

As soon as IC1's gap timer ends, ready to play another bird song, it sets the GP4 output low and so IC2 is now also ready to begin singing. Random delay periods added between the GP4 output going low and the IC2 bird singing give the effect of the two birds singing together, sometimes but not always in synchronisation.

Each microcontroller drives its piezo transducer from the GP0 and GP1 outs, pins 6 & 7 with out-of-phase 3V signals; ie, when GP0 is high, GP1 is low and when GP0 is low, GP1 is high. This results in a 6V peak-to-peak drive signal to each piezo.

The 2.2kΩ resistor from the GP0 output is included for two reasons. One is to provide high frequency rolloff for the piezo signal, removing upper frequencies from the square wave drive. The rolloff is due to the 50nF capacitance of the piezo transducer combined with the series 2.2kΩ resistor; the result is a low pass RC filter.

The 2.2kΩ resistor also prevents GP0 from being shorted to 0V when the switch (S1 for IC1 and S2 for IC2) is pressed. Normally, GP0 is set as an output but at power up, GP0 is set as an input with an internal pullup holding this input high unless the switch is pressed.

Pressing the switch causes the microcontroller to change to the next bird sound available. This selection is stored in EEPROM so that the setting remains whether power is off or on.

Saving power

While PCBirdies is switched on, the current drain is 1.8uA per microcontroller during silence and 735µA per microcontroller while singing. Maximum current drain when both birds are singing is about 1.5mA. With the birds singing intermittently (as they do) we expect that you should get about 100 days of continuous use before the cell requires changing.

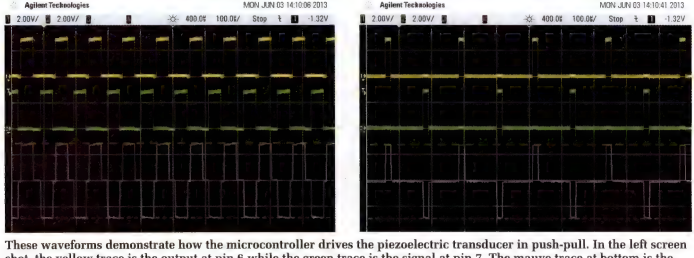
At around $2 to $3 per cell, that's a lot cheaper than bird seed!

Both microcontrollers utilise a watchdog timer which is repeatedly cleared during normal program running to prevent it from timing out and resetting the micro.

Typically the watchdog timer will time out after 2.3 seconds. During the gap period when there is no sound produced, the micro is in sleep mode and is woken up every 2.3 seconds by the watchdog timer (perhaps its barking wakens the napping PCBirdies?)

The number of watchdog timer timeouts that occur is counted to set the gap timer period. The gap timer is reset to zero with the LDR in darkness for IC1 and with GP2 high for IC2.

As already noted, power for the circuit comes from a 3V button lithium cell, type CR2032. Diode D1 is



These waveforms demonstrate how the microcontroller drives the piezoelectric transducer in push-pull. In the left screen shot, the yellow trace is the output at pin 6 while the green trace is the signal at pin 7. The mauve trace at bottom is the difference between the two signals which is applied to the transducer. The resulting waveform is equal to the sum of the two waveforms (in theory) but in practice it is less. The waveforms at right were taken for the same connections as in the scope screen at left but the note is less than half the frequency and the duty cycle is also much reduced.

included to provide reverse polarity protection. Normally this should not happen as the cell will only make an electrical connection to the cell holder if it is correctly inserted.

However, it is not unknown for some constructors to solder cell holders in the wrong way.

If that happens and a cell is inserted, the diode will conduct to protect the two microcontrollers but unless the cell is quickly removed (upon the awful realisation that it is in the wrong way) it will get hot and be quickly discharged.

The lithium cell is bypassed with a 1µF capacitor. Each micro has its MCLR connected to the +3V supply via a 10kΩ resistor. This provides a power-on reset each time power is first applied.

Construction

All components (including the battery and piezo transducers) for PCBirdies mount on a single PCB coded 08104131 and measuring 62 x 48mm. It is housed in a translucent blue UB5 box that measures 83 x 54 x 31mm.

No screws or mounting posts are used – the completed PCB drops into the moulded rails on the side of the box, with the power switch emerging through the side.

A label measuring 78 x 49mm affixes to the lid of the box.

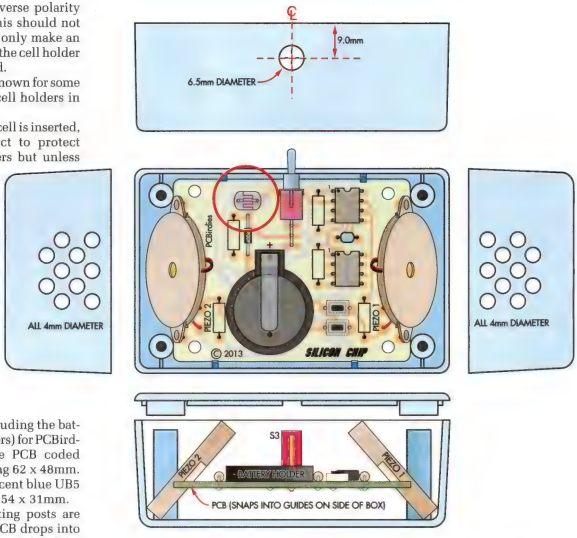
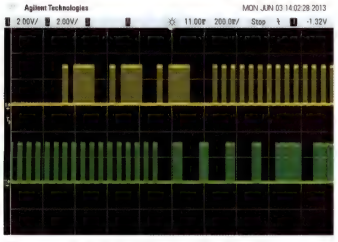
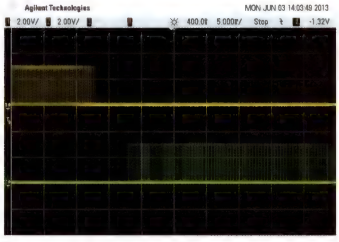


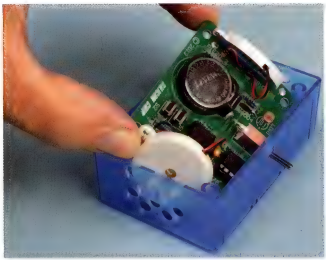
Fig.3: this diagram shows not only how it all goes together in the box but also the positions for the switch hole (S3) and the sound holes in each end. You'll also need a hole in the case lid above the LDR (circled in red) if you don't use a translucent case.



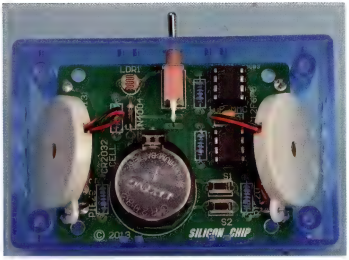
These waveforms show the songs being "sung" simultaneously by the two microcontrollers, with the connections being at pin 7 in each case. Note that the songs are not synchronised even though they start out in sync at switch-on.



Taken at a faster sweep speed, these waveforms show how the beginning and the end of each pulse train has a much reduced duty cycle to avoid any tendency for the piezoelectric transducers to produce audible clicks, which would rather detract from the canary's song!



Once the PCB is built and tested it is inserted in the box. The idea is to "slide" it in so that the power switch (S3) emerges through its hole in the box then the back of the board is pushed down so that it clicks into place in the mouldings on the case.



Here's what it looks like assembled inside the box. Everything is on the one PCB. If you have used anything but the translucent blue box, you'll need to drill a hole in the box lid so that the LDR (top, left of board) can "see" daylight. Otherwise PCBirdies will never turn on!

Parts List – PCBirdies

1 PCB coded 08104131, 62 x 48mm
1 translucent blue UB5 box 83 x 54 x 31mm (see text)
1 PCB mount SPDT toggle switch (S1) (Altronics S1421 or equivalent)
2 2-pin momentary pushbutton PCB mount switches (Jaycar SP0611)
2 DIL8 IC sockets
1 PCB mount 20mm cell holder (Altronics S5056, Jaycar PH9238)
1 CR2032 lithium cell
2 piezo transducers (Altronics S6140, Jaycar AB3440)
1 LDR (Jaycar RD3480, Altronics Z1619) (LDR1)
Tinned copper wire

Semiconductors
2 PIC12F675-I/P microcontrollers programmed with 0810413A.hex (IC1,IC2)
1 1N4004 1A diode (D1)

Capacitors
1 1µF monotlithic multilayer ceramic (MMC)

Resistors (0.25W, 1% or 5%)
1 470kΩ
(4-band code: yellow purple yellow brown)
2 10kΩ
(4-band code: brown black orange brown)
2 2.2kΩ
(4-band code: red red red brown)

Before installing the parts, check the PCB for any faults. Repair these as necessary. If you are building from a kit or using the PCB supplied from the SILICON CHIP shop, you will find that these PCBs are of excellent quality and so will not normally require any repairs.

Follow Fig.2 for the PCB component assembly.

Install the resistors and diode first. The resistors are colour coded with the resistance value. There are only three values of resistor; their colour codes are shown in the parts list. A digital multimeter should also be used to check the resistance values.

Make sure the diode is installed with the correct polarity with the striped end oriented as shown in the overlay diagram.

The capacitor can be installed next, along with the two push button switches and the IC sockets. Make sure the IC sockets are oriented correctly.

Power switch S3 is mounted hard-down on the PCB and its main body terminal is soldered to the PCB before the remaining three switch pins are soldered.

The 20mm button cell holder can be installed taking care to orient this as shown.

If you are using a translucent case, then the LDR can be mounted at about 5mm above the PCB. That way the LDR will receive light through the box sides (even if a panel label is attached to the lid). If a grey or black case is used, the the LDR top face needs to be 14.5mm above the top of the PCB so that it can be inserted into a hole drilled in the lid of the case.

Insert the 3V cell into its holder and check that there is a 3V supply between pins 8 and 1 of each IC socket when switch S3 is turned on. If this is correct, turn the power switch off and mount the ICs.

The piezo transducers are mounted at about a 45° angle on the side of the PCB, sitting within the cut outs. Fig.3 shows the arrangement. We soldered the transducer wires directly into the signal output pads after first looping the wires through the two holes that provide for stress relief.

The piezo transducers have two flanges for mounting and we looped some tinned copper wire through the flanges and soldered these to the pads on the PCB. This keeps the transducers in position with one flange on the top side of the PCB and the other flange on the bottom of the PCB.

The PCB is designed to clip into the integral side rails of the box. A 5mm hole is required in the side of the box for switch S3. The diagram shows where the hole should be.

If you must use a grey or black case, drill a suitable hole for the LDR in the lid, immediately above where the LDR is mounted.

An array of holes is also required in the ends of the box. Use the photos and diagrams for the positioning of the holes and drill these out to 4mm in diameter.

The front panel can be downloaded

Before placing the PCB in the box, you'll need to carefully drill sound holes in each end. If you don't do this there will be two very muffled canaries! The exact positions are not important but you should aim to make the pattern symmetrical about the centre so it looks good!

If you don't get any sound from PCBirdies after final assembly (and it worked before you put the PCB in the box, make sure that the CR-2032 button cell is right down in its holder. Push it down so that it clicks into place to ensure reliable contact.

from the SILICON CHIP website (**www.siliconchip.com.au/shop** and then select "Panel artwork"). It's a free download for subscribers (print or online) but there is a nominal charge for non-subscribers.

Print the label onto good quality thick paper – photo paper is ideal. It can be secured to the lid with a suitable glue or Silicone. The hole for the LDR (required in a solid coloured box only) can be cut out with a sharp craft knife or leather punch.

Changing the songs

When PCBirdies is first turned on, the bird sound produced by both IC1 and IC2 are of the Fife Canary. Changing the bird sound produced by IC1 is done by pressing S1 during power up. Similarly, changing the bird sound produced by IC2 is done by pressing S2 during power up.

Power up involves switching off S3 for a few seconds then switching it on again.

The pressed switch (S1 and/or S2) is released after five seconds from power up. You can either press S1 on its own, S2 on its own or both switches during power up to change the song(s).

If just S1 is pressed and held during power up, then only the song produced by IC1 will change; similarly if just S2 is pressed, it's only the song produced by IC2 that changes. With both switches pressed, songs from both IC1 and IC2 will change.

There are four bird song selections. The Fife Canary bird song is the first that is set in the program. The next selection is a different canary bird song.

The third and fourth selections are medleys of the bird songs. The third selection provides just a few of the more distinctive phrases used within the Fife and second canary songs. These are played at random.

The fourth selection provides a medley of both the full Fife Canary repertoire, the full second canary song repertoire plus the phrases available from the third selection. These are all played at random.

You will return to the original Fife Canary sound with the next selection accessed by S1 and S2 at power up.

If you want to have both IC1 and IC2 play the same repertoire, then press just one of the switches (S1 or S2) as many times as necessary during power up until that IC plays the same song as the other. SC

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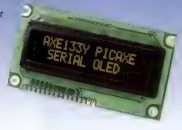

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SERVICEMAN'S LOG

External HDDs – data recovery is no picnic

Dave Thompson*

Many computer users still don't "get" backing up. In fact, it's not uncommon for them to keep just one copy of vital data on an external hard disk drive. But what if it fails? Retrieving data from such drives is not always easy and all too often, important files are lost for good.

Items Covered This Month

- Faulty external HDDs – data recovery is no picnic
- X-ray machine brain teaser
- The PA system that sometimes hummed

EXTERNAL HARD drives have revolutionised how we manage data. In the old days, before large-capacity hard disks, anyone wanting to store gigabytes of data had little choice but to use tape back-up systems which typically stored up to 4GB or more. The main problems with tapes were relatively slow read and write speeds and poor overall reliability; anyone who ever copied data to a cassette tape back in the earliest days of personal computing will remember how fraught with problems that procedure was and how often the read or write failed for some unknown reason.

Back then, all we could do was hold our breath and try again, praying to the computer gods that this time it would work. Saving times of 10 minutes or more were not uncommon for larger files and even if the back-up did succeed, there was no guarantee the data would be intact when you went to load it back into your console.

The larger tape back-up systems that came along a few years later were sometimes no better than those early arrangements, except now the potential for data loss was on a much larger scale. I remember one client who suffered a server failure. He'd backed up to multiple 2GB tape cassettes and was confident that things would be fine because of his (for the time) relatively sophisticated back-up system. He didn't reckon that tapes wouldn't always yield what was stored on them and while we did eventually manage to get him back up and running with most of his data intact, my already low opinion of tape back-up systems had by then been well and truly reinforced.

In its way, the floppy disk also revolutionised data storage, albeit on a much smaller scale than the tape systems of the time, as did the CD and DVD media that followed soon after. With ever-increasing data storage capacity and write speeds, backing up became much less of a chore but many users were still remiss when it came to backing up.

That was hardly surprising given the propensity of floppy disks to lose data while doing nothing more strenuous than sitting in a drawer. What's more, early CD burners were not only expensive to buy and feed but also slow and annoyingly temperamental. If someone sneezed or trod too heavily within earshot of the disk writer during the copy process, the burn would inevitably fail.

Stacks of "coasters" were the lot of early disc copiers and those of us doing such work as an extension of our business soon learned that certain brands of discs were more likely to fail than others in any given burner. As hardware (and write buffers) improved, prices dropped and it wasn't long before most computers boasted a CD burner.

Nowadays, it's an unusual desktop or laptop that doesn't ship with a DVD or Blu-ray writer as standard kit and due to the vast improvements in burn speeds and overall reliability I can't remember the last time I had a disc write failure. DVD and CD media are also dirt-cheap and readily available and though their data capacity is relatively small compared to modern USB flash drives and monster-sized external hard drives, DVDs are still an excellent choice on which to archive your more critical data.

A big problem with large hard drives is that nature abhors a vacuum. In the old days, a 2GB hard drive was something only corporates or early-adopters with deep pockets could afford to buy. What's more, it was almost inconceivable a home user would ever fill such a vast amount of space.

However, as the games industry blossomed and the MP3 music revolution took hold, 2GB was soon barely adequate. Another data-hogging culprit was the new-fangled digital camera. My first camera took 800 x 600 snaps at a then-whopping 0.6 megapixels (which of course now look awful compared to today's 14-plus megapixel efforts). But even that camera's now-laughable file size was enough to force me to purchase a bigger drive to accommodate my ever-increasing photo collection.

It's all very well being able to take

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a gazillion stills and bags of video recordings on your holiday but you have to dump all those files to a hard drive at some point and these days that requires a lot of space. Don't even get me started on movie downloads!

My point is that if you buy a large external hard drive, nature dictates we fill it with data. The current standard is two terabytes (2TB = 2000 gigabytes, or 2,000,000,000,000 bytes, or 1,388,889 floppy disks) which should be enough for most people.

Many of my clients copy data from their computers onto external hard drives as a back-up and this is always a good move. However, some actually move it entirely (ie, it's deleted from the computer's internal drive) in the mistaken belief that cleaning out these files will make their computer faster.

Well, for starters, you'd have to have a pretty full hard drive for your computer's performance to suffer. What's more, moving your files to an external hard drive is not the same as backing up because you still end up with only one copy of your data. And it's stored on a device that's as prone to sudden failure as your computer's hard drive.

Data recovery

And that's where I come in; increasing numbers of clients are now bringing in large-capacity external hard drives that have suddenly stopped working. Because they often have no other copy, they want their data recovered but if the drive has catastrophically failed, I have the unpleasant task of telling them that it's gone forever.

Most faulty external drives I see have failed for one of three reasons: (1) the drive has been dropped or severely knocked; (2) either the USB and/or the power supply connector has been broken off or damaged; and (3) the computer gods have simply decided that the drive should stop working. Just how I approach each drive repair depends on what made it fail in the first place, which is why asking lots of questions to determine what happened can be the difference between successfully recovering data and making things worse.

If the device has been dropped, chances are that the hard drive inside the enclosure has sustained shock damage. Most external drive caddies are reasonably hardy and can withstand a drop onto a "soft" surface such as a carpeted floor without any damage but dropping them onto wood, lino or concrete can break the (typically) plastic case. Usually, the internal electronics survive the fall but it is the hard disk itself that's damaged.

If the caddy's connections have been broken, usually by tugging on the cables or some other mishap, the prognosis is generally good. In such cases, it's usually a simple matter of transferring the hard drive from the existing caddy to another enclosure.

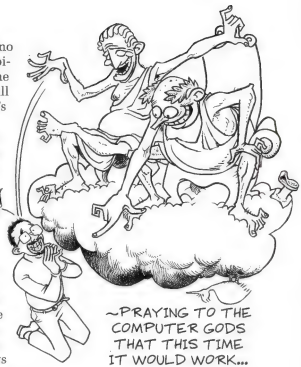
Another reason for opting for a new caddy is that opening up most external drives means destroying the original case. These days, very few are screwed together but instead utilise strong plastic clips that almost always break away when the caddy is prised open. Even if you can get the caddy open without damage, if any of the connectors have been torn off the PCB, it's likely some of the copper tracks have gone with it.

In such cases, soldering the connectors back on can be impossible or, at the very least, a tricky and time-consuming process. The labour charges alone are almost always going to cost the client more than simply swapping the hard drive into an inexpensive replacement enclosure.

Forced repairs

However, there are times when repairing the caddy is the only option if the data on the drive is to be recovered. This scenario is becoming more and more common because several external hard drive manufacturers are now shipping drives designed for external USB use with proprietary firmware. This means that all the relevant USB electronics and connectors are mounted directly on the drive's circuit board, replacing the standard serial ATA (SATA) connectors you'd usually find there.

This makes transferring the hard disk to any of the available standard SATA enclosures a non-starter. So if the client wants their data recovered, you either have to buy an identical hard drive and butcher it for the circuit board in the hope that a control board swap will work (it often doesn't) or you have to repair the broken connectors on the dead drive's existing circuit board.

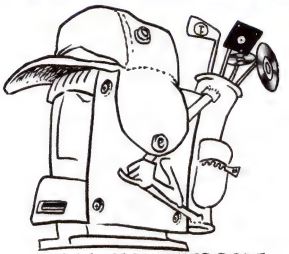


In the latter case, as anyone who has ever tackled such a job will know, it's usually extremely difficult to accomplish without specialist soldering and de-soldering equipment and a great deal of skill.

Another more disturbing (in my view) trend is where vendors are selling "secure" external drives whose contents are protected using hardware encryption built into the caddy's electronics. A unique encryption chip is mounted directly on the caddy's circuit board, pairing the hard drive with that particular enclosure. You can easily remove the drive from the caddy but without the caddy's decoder chip, any recovered data is gibberish and not even advanced forensic data recovery labs can help.

While it's true that the electronic assemblies used in caddies are typically robust and reliable, if you break off the USB connector or otherwise damage the PCB, things start looking very grim data recovery wise. Buyers and users of encrypted external drives should therefore have sound back-ups on other media because if the caddy fails, you're in big trouble.

Of course, the actual hard drive, if still sound, can be removed, reformatted and used in another caddy (if it is a standard SATA hard drive) but any of the previously-encrypted data on it is gone for good. So when buying an external hard drive, check the packaging as it should clearly state whether the drive uses built-in (hardware) encryption.



~ MOST EXTERNAL HARD DRIVE CADDIES ARE REASONABLY HARDY

Basically, it boils down to this: non-standard drive interfaces and data encryption are making data recovery from external drives increasingly difficult for the computer technician.

User abuse

I've also found many external drive users are under the impression that portable drives are designed to be robust and thus don't treat them as gently as they should. I was told years ago that if you stand a computer hard drive on its edge on the bench and tip it over, the shock of it falling even that small distance would kill the drive. I've never tried it but I don't doubt that it could happen.

Some external drives are even specifically marketed as "rugged" devices, apparently capable of taking a knock on the desk or a drop to the floor. I wouldn't bet on it; in my experience the majority of hard drives are secured into caddies with either standard screws, hard plastic clips or at best, mounted on thin rubber grommets that offer the barest minimum of shock protection. Some so-called rugged drives boast a rubberised outer "skin" but this is more for show than anything.

The truth is, all hard drives, regardless of type, should be treated with the utmost care because if they get damaged, more often than not your data goes with them. If a drive is running and it is knocked or dropped, the magnetic read/write head – which usually just clears the surface of the drive – can actually touch and score the platters. And if that happens, both the head and platters will be ruined and data will be lost. Even specialist data recovery houses usually cannot recover data from scored platters.

Many clients come into my workshop with unrealistic expectations, assuming data recovery from their non-working drive is as simple as copying it off to another drive. Sometimes it is but most people are surprised when I tell them the reality of their situation. One client was visibly shocked when told this because he didn't realise that external drives could actually fail. He had simply assumed that once his data had been copied onto it, it was on the drive forever.

Some recent cases

When faced with a non-working external drive, we first remove the drive itself from its caddy and "spool" it up in our recovery machine (assuming of course, that the drive has a standard SATA interface). The best-case scenario is that the drive itself is OK and I can then simply mount it in a shiny new enclosure and off the client goes.

However, it is rarely that straightforward and I recently had two cases which are typical of the data recovery challenges I'm facing these days. Both cases involved external hard drives that were no longer working.

The first was a large, mains-powered model that used a standard 3.5-inch computer hard disk and had inbuilt data encryption. The second was a near-new passport-style drive which used a 2.5-inch laptop hard drive with proprietary firmware. One client wanted to recover her university documents and the other business data – information neither could do without yet these drives contained their only copies.

In fact, both clients told me that they had stored their files exclusively on these external drives because they thought it completely safe.

The larger, encrypted drive had a broken power socket which was rattling around inside the caddy. These sockets are usually commercial types that you can pick up from any component supplier, so replacing them is easy enough. In this case though, part of the circuit board had also broken off along with the socket, tearing away some copper tracks and peeling others away further down the board.

Because I had to keep the PCB (due to the inbuilt encryption), I repaired it by first gluing the broken piece with the power socket back in place. I then restored all the torn tracks as best I could using individual strands taken from a strip of hook-up wire and forming them into place.

That done, I plugged it into my computer to check that the data was readable before smothering the repaired section of the board with epoxy resin to protect the bare wire strips and to give it some strength. Fortunately, it all worked, so I then tacked the enclosure back together with glue and advised her to copy her valuable data to other drives as soon as possible before ditching the repaired drive.

The passport drive was a bit tougher and the fix involved more luck than skill. The caddy was intact, as were the various connections, but the drive had simply stopped working.

I pulled the drive from the caddy and could hear it was struggling to spin up when connected via a USB cable. Eventually, I concluded that my only hope was a control board swap. Several of my suppliers sold similar drives so I called around and bought one that I thought would be a likely match.

I wasn't all that hopeful though. I've tried dozens of control board swaps over the years with little success. The drives and boards have to be identical in every respect and with constant revisions, this is difficult to achieve

Anyway, having obtained the new drive, I broke open the caddy and swapped its board over to the dead drive. And for once the gods were smiling because the drive now spun up and worked normally.

The now-working drive was then fitted into the new caddy and returned to the client. But he was lucky and my advice to him was to keep more copies of his data because he might not be so lucky next time.

X-ray brain teaser

This next story comes from M. B. of Parramatta, NSW who was recently exposed to a faulty X-ray machine (pun

intended). Here's what happened . . .

I work on X-ray machines and have noticed over the years that some machines have an uncanny ability to break down on Friday afternoons. When that happens, you know you're probably going to be in for a late night yet again. It's a good thing I'm getting too old to have a social life!

Sometimes, there's really nothing wrong with the machine but that wasn't the case with one recent "Friday-night special". At least this particular site was only a short drive away and I fully expected to turn up, check the machine out, find nothing wrong, and then turn around and go home again.

When I got there, it turned out that during their morning checks, the operators had noticed an unusual noise coming from the rear of the machine. This occurred when they tested the circuitry that stops the machine from moving if it gets close to a patient. However, after some experimentation with the system, they eventually got the noise to stop and since the patient detection function was working correctly, they carried on using the machine for the remainder of the day.

I asked the customer to try to reproduce the fault and lo and behold, after a number of attempts to make it fail, the fault reappeared and was now there permanently. That was good news because permanent faults are easier to track down and fix than intermittent faults. However, on the downside, it meant that I now had to stay and fix it!

One large circuit board controls all the movement and I soon discovered that the noise was coming from one of the motion-control relays which was vibrating on and off. The system diagram of this board indicated that the FPGA (Field Programmable Gate Array) output controlling this relay was influenced by two inputs. One was a "patient detected" signal and the other was a reset signal. The operator presses the reset switch when the patient is clear of the machine after the system has detected that the patient was too close.

The hardware reset signal for the patient detection system is fed into the FPGA via a level converter. I checked the signal level at the input of the converter and found it to be at 2.5V. As the circuitry feeding this chip was 12V, I was somewhat surprised not to read either 12V or 0V. I figured that in a 12V circuit, this 2.5V was actually above the low threshold, ie, the reset signal was actually being read as active.

For the sake of convenience, I now decided to replace the control PCB. This particular site has a history of these boards blowing up due to some local mains peculiarity. Also, it doesn't take long to replace this board but as I soon discovered, it wasn't the cause of the fault this time! And that meant that I'd have to think a bit more deeply about the problem!

The reset signal is generated by a switch at the treatment head of the machine. Measuring the output of this switch also revealed 2.5V. However, after disconnecting the ribbon cable that carried the reset signal from the control PCB, the output from the reset switch rose to 12V. This was a better level – the only problem was, it's not supposed to come from the output of a normally open switch!

So what was feeding the voltage back up to the switch? The reset signal is fed through four different cables from the switch to the control PCB and goes through a number of rotating parts. It was possible that, somewhere along the way, a couple of wires were shorting due to worn insulation. It's also possible for a cable to short to the chassis but this would have produced 0V at the switch, not the 2.5V I had.

I disconnected the cable at a couple of convenient places but the switch voltage stayed high. The last place to check was another set of ribbon cables. These cables go through another rotating part of the machine, so I decided to swap a couple of sets to see if one of them was worn. At one end, they connect to an interface patch panel where the signals from a multi-core cable are distributed to the ribbon cables. This board is fastened to a frame and is removed by undoing just two screws.

However, as I started to pull this board out, I noticed some corrosion on its top side. Then after removing all the connectors, I discovered that the connector carrying the reset signal had a white deposit across several of its pins.

Cleaning the corrosion off with some alcohol proved to be quite successful, so I re-connected all the cables and turned the machine back on. Fantastic! – the output of the switch was down to 0V and I thought I'd nailed it. Obviously 12V was feeding from

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The PA System That Hummed . . . Sometimes

R. T. of Narrabeen, NSW recently tackled a puzzling intermittent fault in a council PA system. The complaint was loud hum but the gear behaved normally each time he checked it out. Here's what happened . . .

The story of the "noisy PA amplifier that wasn't" in the July issue reminded me of a somewhat similar episode I had recently – well, at least the report was "horrible noises over the PA".

The problem was that it was intermittent and whenever I happened to be in the area and checked it out, there was absolutely nothing I could do to make the PA system misbehave. This went on for more than a year, until the client (a local council) eventually got jack of me not being able to solve the problem. And I was equally jack of them not being able to reproduce the noise!

So I asked the (very-non-technical) operators to write down the dates and times that the noise occurred, along with anything special that they were doing at the time. Even this was sketchy at best and didn't provide any real clues.

In fact, I heard absolutely nothing from them until a phone call a couple of months later. Not only was it doing it again, it was doing it right now – I could barely hear them over the phone above the awful noise from the PA. To make matters worse, they were getting ready for a function where it absolutely, positively, needed to work. The mayor and some other bigwigs were coming . . .

I said "don't touch anything" and drove down as quickly as I could. Oh no: silence!

I thought that Mister (Intermittent) Murphy had struck again until they told me it was so bad that they just had to turn the system off. So I turned the power switch back on again and, sure enough, was rewarded (if that's the right word!) with a damn-awful and very loud 100Hz hum from the horn speakers.

My first thoughts were that one or more of the electros in the PA power supply had given up the ghost, so I reached for the power switch again. I really needed to give it a visual check but it was when I started to extract the main amplifier from its housing that I noticed an extra coax input going to the PA mixer, leading into another room. It was one that I certainly hadn't installed.

"What's this for?", I asked. "It's for the radio microphone that they use for speeches and such, like we need today", I was told. "But it can't be that because we often have that on and it usually works fine". Hmm. I wonder?

I traced the cable through a hole in the wall back to the wireless mic receiver and turned it off, then went back in and turned the PA system back on again. Silence!

Wireless microphone receiver on? Hum. Wireless mic receiver off? No hum. So you didn't have to be Einstein (or Marconi) to work out where the hum was coming from. I did notice, however, that the hum ceased for the half second or so after power was turned off until it dropped out altogether. That definitely pointed the finger at the receiver and almost certainly at its plugpack supply.

The plugpack itself was a 12VDC 800mA model while the power input DC socket was labelled "16VDC, 500mA". Obviously, the higher current capacity wouldn't matter at all but was it getting upset at the lower supply voltage? Surely not!

It was then that I noticed another plugpack in the drawer where they normally kept the wireless mic and receiver. I picked it up. It was labelled "16V DC, 500mA" and it was definitely lighter that the other one, so it was obviously a switch-mode type. The thing was, both had the same DC output plug.

Then the shilling dropped (it used to be a penny but inflation adds up). I swapped the two plugpacks and switched on – silence. There now wasn't a hint of hum, even with the wireless mic gain wound all the way up. I set the level back to where it was, turned on the wireless mic itself and was rewarded with my own voice – and nothing else.

Obviously, the "sometimes it works and sometimes it doesn't" simply depended on which plugpack they happened to pick up on the day. So why was there another plugpack in the drawer (and obviously not the right one)? Blank faces all round! But at least there were smiles as well as they knew the mayor wouldn't have an apoplexy later in the morning!

So what was to blame? Was it really the slightly lower supply voltage? As it turned out, no. The filter capacitor in the original plugpack was on the way out. Because of limited room inside the plugpack, they're usually sailing pretty close to the wind anyway and get quite hot due to heat from the transformer. It's small wonder they fail.

Later, back in the workshop, the plugpack's output under load, as displayed an oscilloscope, was anything but DC. Instead, it was closer to rectified AC and so the plugpack was "binned". A subsequent check of the PA/wireless mic receiver with a known "good" 12V DC plugpack resulted in the amplifier remaining quite silent, with no signs of hum. So it wasn't the lack of voltage that was causing the problem.

As expected, I haven't heard any further complaints about hum in the PA system. Unfortunately though, I haven't had the heart (yet!) to tell them that the wireless microphone system that someone had convinced them to buy would have to go in the bin after December this year. Yes, it operates in the 800MHz band.

some part of the PCB, through the deposit and back up to the switch via the ribbon cable.

At that stage, I decided to put the original motor control PCB back in and all still seemed to be OK. I had previously turned off the controller for the detection circuit in order to stop the warning piezo buzzer from going off constantly and this had also stopped the relay vibrating.

The next step was to check that the detection system still worked. I turned it back on but much to my disgust, it was still giving problems! The relay

had at least stopped vibrating but the warning buzzer was still on!

After some thought, this made some sense. The system was registering that a patient had been detected but due to the controller reading a reset constantly, the circuit was resetting immediately. However, the initial detection condition was still there. The peculiarities of the signal timing through the FPGA caused the motor controller relay to constantly turn on and off.

Then I noticed that the detection indicator LEDs were lit. Normally, this is just caused by a stuck detection switch and is easily fixed by operating the various detection switches until the faulty switch clears. But no such luck this time. There is a patch panel where all the connections to the switches plug in and it didn't take long to find the faulty line. I decided to bridge out the connector to make sure the buzzer stopped and was 100% sure that it would, so I was very surprised when it didn't!

This was all very unusual and annoying! I examined the cable connecting the patch panel to the patient detection controller and found this to be OK. So was the detection controller PCB faulty? I'd never seen that particular failure mode before and I wasn't looking forward to replacing it with a new board as it requires a time-consuming re-calibration procedure afterwards.

Anyway, I pulled this board out and immediately noticed a small white mark on the back. Closer inspection revealed this to be yet more corrosion of some sort, so out came the alcohol again. Would I get lucky twice? Amazingly, after refitting this PCB and with the faulty line still bridged out, the detection buzzer stopped. So the corrosion had caused the detection circuitry to latch, even after the original fault had been cleared.

All that remained now was to find the stuck switch. A couple of minutes with a multimeter soon tracked it down and it was quickly fixed by physically manipulating it until it had settled back into its correct non-triggered position.

So the fault was caused by two separate boards in different parts of the machine, both suffering corrosion from an unknown source and both causing the same symptoms. Just when you think you've seen it all . . . SC

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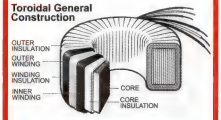

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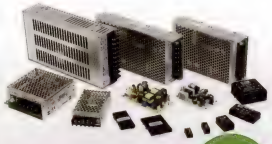
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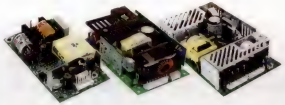
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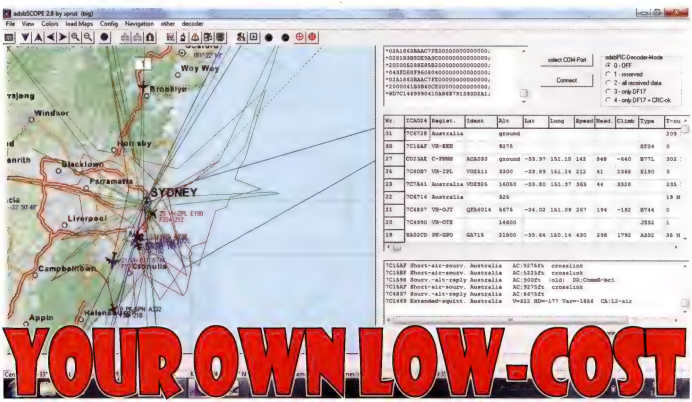
Earlier in this issue we told you about ADS-B and how you could monitor aircraft movements on your own computer screen. But how would you like to go one better: receive and display the actual ADS-B signals transmitted by planes as they fly over you? It's easy – and once again, we're using those bargain USB DVB-T dongles plus some free software. So it's very low cost as well!



YOUR OWN LOW-COST AIRCRAFT ADS-B RECEIVING STATION!

By JIM ROWE

. . . just mix in a PC, USB dongle, antenna, software and stir!

Back in the May 2013 issue of SILICON CHIP, we showed you how to use your PC as a software defined radio (SDR), using a low-cost USB DVB-T dongle plus some freebie software that can be downloaded via the internet.

Then in the June issue we described a low-cost 'upconverter' which extends the bottom end of the SDR's frequency range down to almost DC, so it's able to tune right through the LF, MF and HF bands as well as the VHF and UHF bands covered by the basic PC-plus-dongle setup.

Anyway, just as you may have thought we had exhausted the 'extra' uses of those el-cheapo DVB-T dongles, we were made aware of yet another very interesting use by Victorian reader David Padgett. David drew our attention to the way that at least some of the dongles can be used to receive the ADS-B 'secondary surveillance' signals we talked about earlier in this issue. And that this could be done very easily and at very low cost, using free software that can once again be downloaded from the internet.

One of the USB DVB-T dongles we found on ebay which fits the bill perfectly: it was being offered for the princely sum of $17.66 including postage or "make an offer" so we cheekily put in an offer of $15.00 – which was accepted! Its title on ebay is "DVB-T USB TV FM+DAB Radio Tuner Receiver Stick Realtek RTL2832+R820T" so they are making sure you know what you're getting. Any dongle with this chipset should be fine for ADS-B (1090MHz) even if in the description it states that the range is only 48.25-863.25MHz.

Which DVB-T dongle?

Although you can use many different kinds of USB DVB-T dongle for SDR (as long as they use a Realtek RTL2832U demodulator chip) you are a little more restricted when it comes to ADS-B reception.

That's because the frequency used by ADS-B, 1090MHz, is outside the range of some of the older dongles — in particular, dongles using tuner chips like the Fitipower FC0012, which only tunes up to around 948MHz. Close, but no cigar!

But if you have been using a dongle with one of the Elonics E4000 or Rafael Micro R820T tuner chips, these should be OK for ADS-B as well as SDR since these chips are all rated as tuning past 1090MHz.

A dongle using the R820T might well be a bit better than the E4000 though, because the latter chips have a definite 'gap' in reception between about 1100 and 1250MHz and some tend to taper off in sensitivity before 1090MHz.

Because of this a dongle using the E4000 may turn out to be fine for ADS-B reception, or it may be a bit 'hard of hearing'.

How about dongles using the popular Fitipower FC0013 tuner chip? Well, these can again be fine for ADS-B reception, as they are rated as tuning up to 1100MHz. But some of the FC0013 chips are a bit like the E4000s, with their sensitivity drooping a little before they reach 1090MHz.

So dongles using the FC0013 tuner chip are usually well worth a try for ADS-B, but individual units might prove disappointing.

Now what if you have not bought a USB DVB-T dongle at all as yet, and want to make sure you buy one now that will give good results for both ADS-B and SDR?

In that case I'd suggest that you go for a dongle which uses the Rafael Micro R820T tuner chip, as this one seems to be widely regarded as giving the best results for ADS-B. Make sure the dongle also uses the Realtek RTL2832U demodulator chip, though – this is just as important.

If you look around on ebay, you'll find a number of different low-cost dongles now being offered with the R820T/RTL2832U chip combination specified, for below $30 (some much less). So one of these would be the way to go.

There are also dozens of lower-price dongles being offered on ebay – for as little as $6-$7 or so (some including postage!). Most of these don't specify any particular chipsets (beware – may not work at all for ADS-B!) while many others specify the FC0013 tuner chip (which *may* be OK, as mentioned above). Because there are so many being offered, you can afford to be very choosey and get that R820T tuner – even if it costs you a little more.

Also note that many state that their frequency range is only 48.25-863.25MHz. If it has the R820T tuner, you can be reasonably sure it will go significantly higher than this so is suitable for ADS-B reception.

The antenna for ADS-B

Choosing an antenna for ADS-B reception is a little different from what you need for SDR. That's mainly because with ADS-B we are only interested in reception at one specific frequency (1090MHz), whereas with SDR we wanted to cover a wide range of frequencies.

ADS-B signals from aircraft in your area – those you can see – are also fairly strong, so a modest antenna can give surprisingly good results – even indoors, near a window. But bear in mind that ADS-B signals are vertically polarised, so whatever antenna you use needs to be orientated to suit.

Since a wavelength of 1090MHz is very close to 275mm, this means that you could go for a half-wave dipole (or 'bow tie', or bi-conical) antenna with an overall length of 137.6mm, or a quarter-wave whip just 69mm long. And many people seem to advise that whichever antenna you use, it should be located outside and as high as possible, away from trees and buildings.

However, since I had on hand a couple of those 'toy' whip antennas that come with the el-cheapo DVB-T dongles, I decided to try cutting one of these down to an effective length of 69mm, just to see how it went.

As supplied, these whips seem to have an effective length of about 130mm, so adapting them for ADS-B reception is basically cutting them down to about half-size. I did this by pulling off the small plastic 'bumper' at the top, sawing the rod to length with a small jeweller's hacksaw and then pushing the plastic bumper back onto the cut end.

So how did this 'cut down quarter-wave toy whip' go? Surprisingly well, as it happens, although I must admit that my location is only about 3km from Sydney Kingsford-Smith airport (yes, they shake my place as they come in to land!).

This 100-3300MHz "discone" antenna from Icom Australia (Cat AH8000) would be perfect for use at 1090MHz, the frequency used by ADS-B on all aircraft. It's priced at about $100 and is available from Icom dealers around the country. (www.icom.net.au)

You can see the kind of results I was able to achieve using this very modest little antenna in the screen grab. Some of them were taken while I was using the 'toy' antenna inside, near my office window. Others show the results I got when I took the dongle and laptop outside into the back yard, with the 'toy' mini-whip placed up on the top of the rotary clothesline. Pretty impressive, wouldn't you say?

I also tried using my VHF/UHF discone antenna, as shown in the May article on SDRs (page 13). The results with this one for ADS-B were also fine, although possibly not quite as good as the cut down mini whip.

So a cut down mini-whip antenna is likely to give you quite good results for ADS-B, even inside (as long as it's fairly close to a window). I suspect the only way you'd get better ADS-B reception would be to make up a vertical half-wave dipole or 'bow-tie' antenna, mounted up fairly high - like at the top of your TV antenna mast.

Even better, and something we are looking at for a future issue, is a "collinear" antenna for 1090MHz. The beauty of these is that you can keep adding sections for higher gain – and by definition, they are vertically polarised.

The all-important software

With the hardware side clarified, let's move on to look at the software side of what you need for ADS-B reception. As you might expect, the software is the key to 'making it all happen'.

You may recall from the May article that with SDR, there are two main software items needed: (1) a driver which allows the PC to communicate via the USB port with the Realtek RTL2832U demodulator chip inside the dongle; and (2) the application software which allows the PC to perform all of the necessary processing and display - in that case to perform as an SDR.

The requirements for ADS-B reception are quite similar and in fact the first 'driver' item is the same. That's because we again need the PC to be able to communicate with the Realtek RTL2832U demodulator chip. So if you have already installed the RTL-SDR driver for SDR work, there's no need to install it again for ADS-B reception.

When it comes to the ADS-B application software, though, there are a number of options. That's because there are now two separate functions to be performed: decoding the ADS-B squitts and squitters being picked up by the chips in the dongle, then processing these decoded squitts so all of the aircraft currently 'in view' can be displayed on your PC's screen together with all of their status information.

There are several ADS-B decoding applications currently available for free downloading from the web. The two that seem to be the most popular are ADSB# and RTL1090, the first written by Youssef Touil and Ian Gilmour and the second by a group in Germany. If his name rings a bell, Youssef Touil is the same programmer whose team brought us SDR# and in fact ADSB# can be downloaded from the same website as before (see download links box).

The alternative RTL1090 decoder can be downloaded from the website shown in the same box.

There are quite a few other applications available for processing and display of the decoded ADS-B information. Three of these go by the names ADSBScope, Virtual Radar Server and PlaneSpotter. The first two are freeware but PlaneSpotter is trialware - you can try it for 21 days, but then to continue using it you have to buy a licence for 25 euros.

You'll find the web links for downloading each of these applications in the data box accompanying this article. Note that the ADS-B decoding applications just do the decoding, so you need to use one of the processing and display applications to complete your ADS-B receiving setup. Luckily you can 'mix and match' to a large extent, using either ADSB# or RTL1090 for the decoding and then either ADSBScope, Virtual Radar Server or PlaneSpotter for the processing and display. If you have two or more PCs on a network you can even have the dongle and decoding application on one computer and the processing and display application on another computer, with the decoded ADS-B data stream passing over the network.

In the space available here we're really only going to be able to cover the installation of the RTL-SDR driver together with one of the ADS-B decoding applications and one of the processing and display applications. The particular ADS-B decoding app we'll be covering is ADSB#, and we'll be coupling it to the ADSBScope app for processing and display.

First, the RTL-SDR driver

Not surprisingly, the RTL-SDR driver must be installed before you can move on to install the application software. So if you haven't previously installed the driver for SDR work (as described in the May article), you had better do this now. To help you, we'll repeat the instructions given in the May article:

The easiest way to install the RTL-SDR driver is by using an open source driver installer program called Zadig. Developed a couple of years ago by Pierre Batard, Zadig has been upgraded many times and is currently available as version 2.0.1.160 - in two forms, one for Windows XP and the other for Windows 7. They can both be downloaded (in self-installing exe form) from the web address given in the links box. Make sure to get the right one for the version of Windows in the PC you'll be using for SDR. There is (currently) no version to suit Windows 8 – but then again, we haven't found any USB dongles suitable for Windows 8 either!

Note that both of these files are compressed in '7z' archive format, so you won't be able to extract the self-installing exe files with WinZip. They can only be extracted using 7-Zip, so you may need to download and install this first. Then you can download the correct (and latest) version of Zadig, after which you can use 7-Zip to extract the Zadig.exe installer file. Then you can run this file to install Zadig itself.

Note that with Windows 7, you have to run the installer file as the Administrator – this is very important, as otherwise it won't install Zadig correctly.

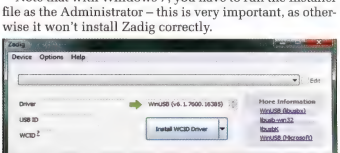


Fig.1

Once installed, you can plug your DVB-T dongle into the USB 2.0 port you intend to use for ADS-B. Windows will

then go through its usual rigmarole, looking for what it thinks is a suitable driver for the dongle. Don't worry if it does this though, because you'll be using Zadig to install the correct RTL-SDR driver shortly.

Now start up Zadig in the usual way. With Windows XP, you should immediately see a window similar to that shown in Fig.1.

With Windows 7, you'll almost certainly get a User Account Control window first, asking you 'Do you want to allow the following program to make changes to this computer?' and listing the Program name (Zadig), the Verified Publisher (Akeo Consulting) and the File Origin (Hard drive). You'll have to click on the [Yes] button before Windows 7 will let Zadig run, to display the same startup window as in Fig.1.

Next click on 'Options' in the top menu bar and you should see a drop-down menu like that shown below (Fig.2).

Fig.2

Click in the blank area just to the left of 'List All Devices' and the drop-down Options menu should disappear. But there should now be some text displayed in the main drop-down menu bar, probably for one of your USB devices like a mouse, keyboard or printer. And if you now click on the 'down arrow' at the right-hand end of this menu bar, you should get a drop-down list of all of the USB devices that Zadig has been able to find connected to your PC (as shown in Fig.3).

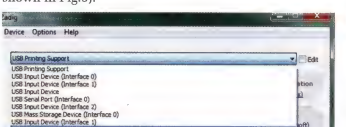


Fig.3

Look down through this list to find the DVB-T dongle which you have plugged into one of the USB ports. The only catch here is that depending on the dongle, it will be listed under various different names. Some dongles may appear as 'RTL2838UHIDIR' as shown highlit at the bottom of the list in Fig.3, while others may be shown as 'Bulk-In, Interface (Interface 0)'. Still others may appear as 'RTL2832U' or similar. The main things to look for are either that 'Bulk-In, Interface' label or one starting with 'RTLxxxx'.

When you spot the dongle in Zadig's list, click on its entry so that it becomes highlighted.

Zadig should now display the dongle's label in the main horizontal bar, as shown in Fig.4. However at this stage it probably won't show anything in the text box just to the right of the 'Driver' label, or else it'll be showing whatever driver Windows installed (or tried to install) when you first plugged the dongle into a USB port. Either way you probably will see text items in the two smaller boxes to the right of the 'USB ID' label, rather like the text that can be seen here in Fig.4:

Fig.4

Now turn your attention to the large blue rectangular button at the lower centre of the Zadig window, which will probably be displaying the text 'Reinstall Driver'. If it isn't, click on the downarrow at its right-hand end to find Reinstall Driver in the drop-down list.

Then once the text is displayed in the main part of the button, click on this button to set Zadig to work installing the correct RTL-SDR driver.

After whirring away for a few seconds, Zadig should display a 'Successful Install' message and then you should see the correct driver name displayed in both the text box just to the right of the 'Driver' label and also in the box further to the right, just to the right of the large green arrow. (You can see the driver displayed in this box in Fig.4)

Use the same USB port!

The driver should now have been installed correctly, and should be called up automatically whenever your dongle is plugged into the same USB port at a later time. So if you always plug the dongle into the same port when using it for SDR, you shouldn't have to fire up Zadig to reinstall the driver again.

But note that Zadig only installs the SDR driver linking to the dongle via that particular USB port; if you plug the dongle into another USB port, you'll have to run Zadig again to reinstall the driver for that port.

Now that Zadig has installed the SDR driver, you can exit from it by clicking on the red button at upper right (the one with the usual red 'X'). But before you move on to download and install the ADS-B application software, it's a good idea to go into Control Panel > System and Security > Device Manager to make sure the driver has been installed correctly.

Down near the bottom of the list of devices, you should see a subheading 'Universal Serial Bus Devices' as shown at lower left in the screen grab overleaf. Then when you click on the arrow to the left of this subhead, you should see a device with the same name as you've seen previously in Zadig (it's shown as 'RTL2838UHIDIR' above). This will be your dongle, and if you then right-click on this device name and select 'Properties', you should see another small indow open up like that shown on the right in Fig.5. If

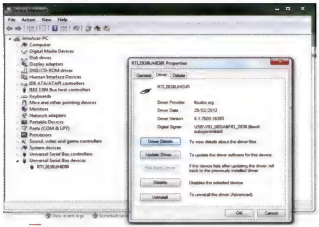


Fig.5

you then click on the Driver tab in this window, you should be presented with the details of the driver that Zadig has installed for it.

As shown above, the Driver Provider should be shown as 'libusbx.org', and the Driver Version as '6.1.7600.16385' (or another number if it has been updated from the current version).

If all seems well so far, it's likely that Zadig has correctly installed the RTL-SDR driver for your dongle, and you'll be ready to proceed with installing the application software. So you can back out of Device Manager and Control Panel and return to your desktop.

ADSB#, the decoding app

The next step is to download and install the ADS-B decoding application, in this case ADSBSharp. This can be downloaded from the website shown in the links box, and as you can see it comes in zipped-up form.

You then need to create a new subfolder in your Program Files folder (like C:\Program Files\ADSBSharp), extract the files from adsbsharp.zip using Winzip and copy them all to the new subfolder. Then when you use Windows Explorer to look at the files on that subfolder, you should see the list as shown in Fig.6.

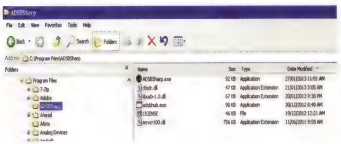


Fig.6

ADSB# is clearly visible at the top with its little 'radar screen' icon, with the name ADSBSharp.exe. This is the decoder program itself, and if you double-click on it the program should fire up to display the small control window visible on the left as seen above right in Fig.7.

As you can see, the ADSB# window isn't nearly as 'busy' as the one for SDR# which we looked at in the May article. It has a rectangular button at upper left with a blue border, which is clicked on to start or stop the application. Then there's a text box at upper right showing the IP port number

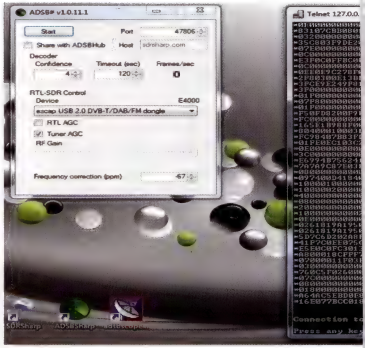


Fig.7

that will be used to communicate with your processing and display app (the default port number is 47806, as visible in the grab below). This should be left with the default number.

Below the main Start/Stop button is a small button with the caption 'Share with ADSBHub'. There's no need to click on this button unless you're going to be sharing the output from ADSB# with other PCs on your network, or with sdrsharp.com via the internet.

Moving down, you'll see the caption 'Decoder', with two text input boxes labelled 'Confidence' and 'Timeout (sec)'. Inside the input boxes there will be default values for the confidence level that ADSB# will be using for decoding ADS-B signals ('4' indicates that it will need that many ADS-B packets from a single ICAO ID target, before it recognises that

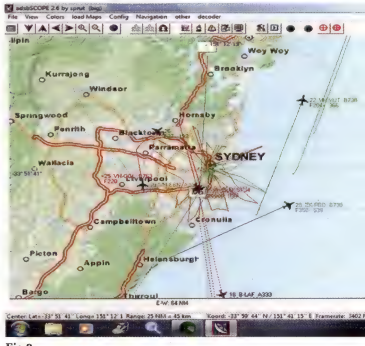
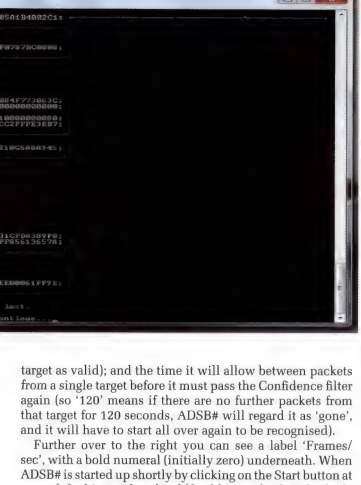
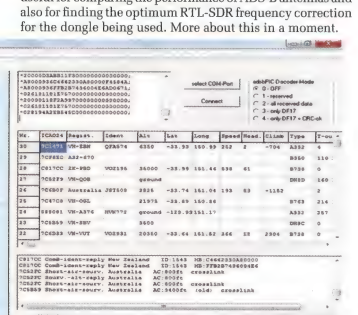


Fig.8



target as valid); and the time it will allow between packets from a single target before it must pass the Confidence filter again (so '120' means if there are no further packets from that target for 120 seconds, ADSB# will regard it as 'gone', and it will have to start all over again to be recognised).

Further over to the right you can see a label 'Frames/sec', with a bold numeral (initially zero) underneath. When ADSB# is started up shortly by clicking on the Start button at upper left, this number should build up as the decoder finds ADS-B data frames. Since the number shows how many of these data frames are being received each second, it can be useful for comparing the performance of ADS-B antennas and also for finding the optimum RTL-SDR frequency correction for the dongle being used. More about this in a moment.



As you can see, the lower half of the ASDB# window is concerned with controlling and optimising the RTL-SDR driver settings, and consequently 'tuning up' the chips in the dongle. At the top of this section is the label 'RTL-SDR Control', plus the label 'Device' above the left-hand end of the long horizontal text box. Inside the text box there should be the name of the dongle you have installed the RTL-SDR driver for, like the 'ezcap USB 2.0 DVB-T/DAB/FM dongle' visible in the box in Fig.7. You may have already noticed that the tuner chip in the dongle is also displayed above the right-hand end of the text box (here it's 'E4000').

By the way if the name of your dongle is NOT displayed already in the text box, you need to click on the small 'down arrow' at the right-hand end of the box, which should cause a drop-down list to appear. You should then find your dongle's name in this list. If you click on it, ADSB# should then display its name in the main text box and make it the one being used.

Just below the main text box you'll see two square 'radio buttons', one labelled 'RTL AGC' and the other 'Tuner AGC'. Then below these is a horizontal slider bar, labelled 'RF Gain'. These three controls are all provided to allow you to manage the raw RF gain of the chips in your dongle, and also the way its AGC is operating. You can of course experiment with these controls to see which 'recipe' seems to work best, but my suggestion is that you simply drag the RF Gain slider to the right-hand end, and then click in the 'Tuner AGC' square button so that tuner chip AGC is enabled. This will cause a small tick to be displayed in the button, as you can see in Fig.7.

The one remaining control on the ABSB# window is down at the bottom, labelled 'Frequency Correction (ppm)', with a text input box to its right. If you have been using SDR#, this will be familiar to you since SDR# provides exactly the same control. As before the idea is to allow the application to make a correction for any frequency error present in the dongle's crystal oscillator. Most of these do have a small frequency error, so by correcting for it we can make sure that when ADSB# tunes the dongle for reception at 1090MHz, it really does tune to this frequency.

Now if you have already been using your dongle with SDR#, you have probably used SDR# to find the dongle's frequency correction using the simple technique we discussed in the May article. So before you start up ADSB#, it's a good idea to type the correction into the text box (with a minus sign if it's negative). Or you can click on the up or down arrows at the end of the box, to get to the correction figure incrementally. As you can see in Fig.7 the dongle I was using when this grab was taken needed a frequency correction of -67ppm (parts per million).

Of course if you haven't found the dongle's frequency correction using SDR# and don't even have it installed on the PC you're going to be using for ADS-B reception, you can't feed a correction into ADSB# at this stage. So leave the correction figure set to the default '0', and then you can change the setting later when ADSB# is running, to achieve the highest Frames/sec reading (at centre right). This is the 'trial and error' approach to correcting for the dongle's frequency error.

At this stage you should be ready to click on ADSB#'s Start button at upper left, to set it running. If all is well so far, you should see the Frames/sec figure start to build up at centre right as ADSB# decodes the 'squits' and 'squitters'

Downloading ADS-B software

To install the RTL-SDR driver, you'll need Zadig (available in two versions, to suit Windows XP or Windows 7).

Download these (as self-installing exe files) from:
sourceforge.net/projects/libwdi/files/zadig

Note however that whichever of the two versions of Zadig you get, it will be compressed in the "7z" archive format. Since this means they have to be extracted using 7-Zip rather than Winzip, you may need to download and install 7-Zip first (unless you have already done so previously). 7-Zip can be downloaded either from either **sourceforge.net** or **www.7-zip.org**, but note that it too comes in two versions – one for Windows XP and the other for Windows 7.

ADSB decoding applications:

ADSB# can be downloaded from
http://sdrsharp.com/downloads/adsbsharp.zip

A Quickstart guide for ADSB# written by Henry Forte can be downloaded as a pdf file from:
www.atouk.com/wordpress/?p=247

RTL1090 can be downloaded from
http://rtl1090.web99.de/

ADS-B processing and display applications:

ADSBScope can be downloaded from
www.sprut.de/electronic/pic/projekte/adsb_en.html#downloads

Virtual Radar Server can be downloaded from
www.virtualradarserver.co.uk

PlaneSpotter can be downloaded from
www.coaa.co.uk/planespotter.htm

from aircraft in the surrounding sky. (If the figure doesn't seem to be building up, you may either have an antenna problem or else you're going to have to play around with the dongle's frequency correction at lower right, because it isn't tuning close enough to 1090MHz.) Or it is possible that there are no planes in your area close enough to receive.

The buildup in ADSB#'s Frames/sec figure is the only indication you get that the application is running, apart from the legend in the button at upper left changing from Start to Stop.

Since this is not all that reassuring, you may want to try firing up Windows' Telnet utility, which can show you the decoded ADS-B data streaming from ADSB#. This will let you make sure that ADSB# is fully functional before you install and run the ADS-B processing and display application.

In case you're not familiar with Telnet, it's a simple IP text terminal utility which is included with Windows XP. In the case of Windows 7 it is also present but must be activated before it can be used.

To do this, begin by clicking on the Start button and then on Control Panel. Click on Programs, and then click on Turn Windows Features on or off.

You may be prompted for administrator confirmation, but if so just do this and you'll be presented with the Windows Features dialog box. If you select the Telnet Client check box and then click the OK button, Windows 7 will download Telnet from the Microsoft website and install it ready for use.

Once you have Telnet available it's not all that difficult to use it to display the data stream coming from ADSB#. Here's the procedure:

Click on the Start button at lower left, and then click on the Run... icon. This will open up the Run dialog box, with the label 'Open:' followed by a text input box. Type in 'telnet' and click on the OK button. Telnet's command line window will then appear on the desktop, with the title C:\WINDOWS\system32\telnet.exe across the top. There's then a greeting message in the box itself, followed by a brief explanation of how to leave the program and finally the command line:

```
Microsoft Telnet>
```

Now type this command (note the spaces between the three fields):

```
open 127.0.0.1 47806
```

and hit the Return/Enter key. If ADSB# is running you'll see a long listing of the decoded data coming from it, as shown in the right-hand window of Fig.7. The data is displayed in hexadecimal strings, with each string preceded by an asterisk and ending with a semicolon. Ordinary Mode S transponder squits are of 14 hex digits (i.e., 56 bits of data), while the extended squitters from aircraft with an ADS-B transmitter are of 28 hex digits (= 112 bits of data).

So if that's the sort of listing you see, you can be assured that ADSB# is running as it should and decoding the ADS-B data being received by your dongle. You can now stop ADSB# by clicking on the Stop button, whereupon Telnet will report that:

```
Connection to host lost.
Press any key to continue...
```

Then if you do press any key, it will return to its command line. All you need do to exit from Telnet and close it down is to type in 'q' and then hit the Return/Enter key.

You'll now be back at your desktop, and ready to install the last link in your ADS-B receiving chain: the processing and display application.

ADSBScope, the display application

The ADS-B processing and display application we're going to discuss here is ADSBScope, which can be downloaded from the website shown in the Download Info box. When you go to that website and folder, you'll find there's a choice of two versions. I suggest that you select and download the file under the heading 'Regular Version 2.6', described in the link below the heading as:

```
ZIP-File with all relevant data (13MB)
```

If you click on this link, you'll begin to download a file called adsb_all.zip, containing not only all of the app's binary files but also a couple of PDF files, one a 'Quickstart' manual and the other a more elaborate manual with more info regarding ADS-B reception with a DVB-T dongle, antennas and so on.

The English in these manuals is a bit hairy and 'Germanic' but they're reasonably informative.

So when you have downloaded the adsb_all.zip file to a temporary folder, extract all of the files into the same folder. This is a good time to print out the two pdf files, so you'll have them for reference. Then open the subfolder pc_software, and you'll see a further subfolder called adsbscope. If you open this you'll find yet another subfolder called 26, and this contains the application you want and all of its own subfolders.

The next step is to create another subfolder in your Pro-

gram Files folder where ADSBScope is to be installed (like C:\Program Files\ADSBScope\). Then you can copy all of the files and subfolders in the downloaded 26 subfolder into this new ADSBScope subfolder.

Now, if you look in your newly created C:\Program Files\ADSBScope\ folder, you should find two executable files: adsbscope26_16384.exe and adsbscope26_256.exe. These are two slightly different versions of the app, differing only by how many aircraft they can track simultaneously (256 or 16,384).

So to get ADSBScope up and running, simply double click on either one and in a few seconds you should see its main window – a bit like the one shown in Fig.8, although at this stage the map shown in the graphical display window on the left will probably show an area around Prague, in the Czech Republic. (This is ADSBScope's default location.) The other data fields over on the right will probably all be blank as well, although there may be a bit of general information displayed in the small upper text box.

By the way before you actually start up ADSBScope, you should start up ADSB# so that it is delivering a decoded ADS-B data stream for ADSBScope to work on.

Now the first thing to do when you have started up ADSBScope is to advise it of your actual location (assuming you don't live in Prague, that is). To do this, click on the Navigation menu heading at the top.

This will bring down a drop-down dialog like that shown in Fig.9.

Fig.9

Then click on the line labelled 'goto Town or Airport...', which will open the dialog box shown in Fig.10.

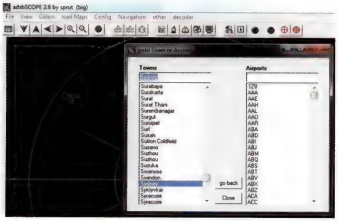


Fig.10

This has two long scroll-down lists, one for cities and towns on the left and the other for airports on the right. Scroll down one or other of these lists, until you find your city or airport. Click on that name or airport code to select it, and finally click the Close button.

You should find then that the centre of ADSBScope's graphical display will switch from Prague to the centre of your selected city or airport. However it will probably have a black background, so if you click on the eighth button from the left (the one with a small 'world globe' icon on it) in the top row above the graphical display window, as shown in Fig.11. ADSBScope will search Google maps and replace the black background with a colour map of your area.

Fig.11

You need to make sure that ADSBScope regards this location as your new default location, rather than Prague. So go back to the Navigation menu, and click on the 'set Receiver Location line at the top (you can see it in Fig.9). You'll find that ADSBScope will display a 'WARNING!' dialog, as shown in Fig.12. But since changing the receiver location is exactly what you do want to do, simply click on the OK button and it will do the job.

Fig.12

Now you need to tell ADSBScope how to establish a link to your source of decoded ADS-B data, which in this case is ADSB#.

To do this, click on the 'other' menu titlе on the top menu bar (between 'Navigation' and 'decoder'). This will provide the drop-down menu shown in Fig.13, and if you then click on the 'Network' line at the top, another flyout menu will appear at the right (as also shown in Fig.13).

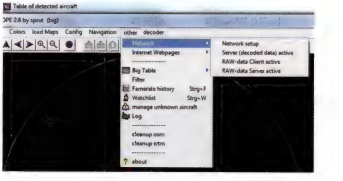


Fig.13

Now click on 'Network setup', at the top of this sec-

ond menu. You will then be greeted by the Network setup dialog shown in Fig.14.

There's no need to worry about most of the options and information visible in this dialog, because ADSBScope's programmer 'sprut' has thoughtfully provided some preset decoder 'recipes' down near the bottom of the dialog.

There's a preset provided for ADSB# – so if you click on this preset button, ADSBScope will fetch the preset data for ADSB# and change the settings to those you see in Fig.14: Portnumber 47806, URL 127.0.0.1 and 'normal' data format rather than 'binary'.

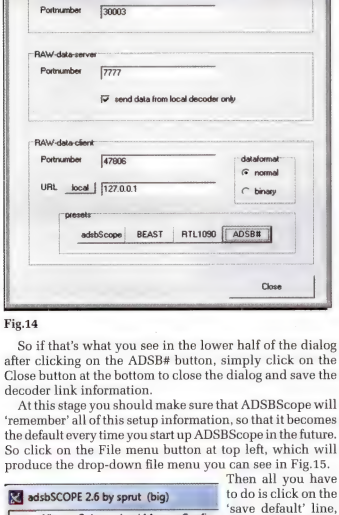


Fig.14

So if that's what you see in the lower half of the dialog after clicking on the ADSB# button, simply click on the Close button at the bottom to close the dialog and save the decoder link information.

At this stage you should make sure that ADSBScope will 'remember' all of this setup information, so that it becomes the default every time you start up ADSBScope in the future. So click on the File menu button at top left, which will produce the drop-down file menu you can see in Fig.15.

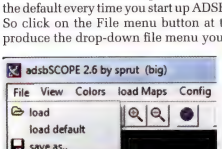


Fig.15

Then all you have to do is click on the 'save default' line, and ADSBScope will save the complete current setup as its default.

At this stage ADSBScope has been setup for operation at your location and with your decoder, but nothing much will appear to be happening because it still hasn't been told to 'get going' by linking up to the decoder's data stream. Luckily this final step is very easy: all you have to do is click on a button in the top row above the graphical display window – the one with an icon showing five little PC's in a ring, just below the Navigation menu. If you pass your mouse over this button, you'll see the clue text as shown in Fig.16 ('start RAW-data CLIENT').

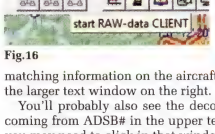


Fig.16

So click on this button, and you should see ADSBScope spring into life. Within a few seconds, you should see aircraft starting to appear in the graphical display, and matching information on the aircraft will be appearing in the larger text window on the right.

You'll probably also see the decoded hex information coming from ADSB# in the upper text window, although you may need to click in that window for it to appear.

Down in the smaller text window you should also see the fully decoded ADS-B and Mode S data, although if this doesn't happen (and you don't even see a lower text window) you need to click on the button at the top of the screen with an icon showing a hand writing in a notebook with a pencil (just to the right of the one with an open book and question mark).

If you pass the mouse cursor over this button you'll see the clue text 'show decoded data'. But when you click on this button, a lower text window will appear with the decoded data scrolling past. So everything should now look rather like the screen grab in Fig.8, although the details will of course depend on your location and the aircraft 'in view'.

You have now fully installed and set up ADSBScope, and your ADS-B receiving station is fully operational.

You'll find that ADSBScope has many more features than we've looked at here, but you'll have to read the author's Quickstart manual and his more complete manual, for more information on making use of them. There's plenty of opportunity for experimenting.

Comparing antennas

To end up (and hopefully whet your enthusiasm), there are two similar screen grabs shown in this article. The display on the opening page (p40) shows my setup with ASDB# linked to ADSBScope, using a dongle with an E4000 tuner chip and a cut-down mini-whip antenna.

The only difference between this screen grab and the one in Fig.8 is that where Fig.8 shows the kind of result I was getting using the laptop, dongle and mini-whip in the office, the opener shows the kind of result with everything out in the backyard and the mini-whip on the top of the rotary clothesline centre pipe. (And you thought that rotary clotheslines were only for kids to swing on . . .)

As you can see there are more aircraft visible in the 'outside' configuration, but not dramatically so.

The other thing to note is that the results with the mini-whip antenna are pretty much as good as you'd expect with any antenna. So depending on your location, this kind of el-cheapo antenna might be all you need for ADS-B reception too.

So that's ADS-B – your choice as to whether you view it via the internet or view the actual transmissions from 'planes in your area. SC

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Pan/Tilt DIY Wi-Fi IP Camera

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- Two way audio
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- Pan/Tilt Angle: 320° Pan, 120°
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QC-3839 **720p**

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Also available:
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QC-3831 NEW $89.00

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These new inverters provide standard protection as well as host of additional features to improved performance and reliability under adverse conditions. Including a soft start feature to reduce inverter overload when used on large appliances. All models include a standard 230VAC mains outlet and a USB port for powering and charging USB devices. See the website for full specifications.

- 12VDC Input voltage

180W - MI-5700 $189.00 - Size: 186(L) x 117(W) x 57(H)mm
360W - MI-5702 $229.00 - Size: 230(L) x 118(W) x 57(H)mm
800W - MI-5704 $399.00 - Size: 295(L) x 165(W) x 57(H)mm

NEW FROM $189.00

Speed Control Kit for Induction Motors

Refer: Silicon Chip Magazine April/May 2012 + Aug 2013

Control induction motors* up to 1.5kW (2HP) to run machinery at different speeds or controlling a pool pump to save money. Also works with 3-phase motors. Full form kit includes case, PCB, heatsink, cooling fan, hardware and electronics (including revisions from the August Silicon Chip article).

KC-5509

Please note that this is an advanced project for an experienced constructor.
*Does not work for motors with centrifugal switch

$249.00

4 Stage 40A DC to DC Boost Charger

Capable of taking an 8-16VDC input voltage, and boosting up the output voltage to give a regulated 13.8V/14.4V 4-stage charger output to give your auxiliary battery a full 100% charge. Output current is rated at 40A to ensure a quick charge.

- Input voltage: 8-16VDC
- Output voltage: 13.8V/14.4V/14.8V
- Output current: 40A
- Size: 260(L) x 140(W) x 80(H)mm

MB-3690

NEW $299.00

Also available:
24V to 12VDC to DC Batt Charger
MB-3691 NEW $299.00

Wireless DVR & Camera Kit 2.4GHz DIGITAL

Keep the perimeter of your home or business secure without running wires. The integrated PIR sensor provides reliable motion detection, triggering both the camera and 2 x 5W LED lights when active. Footage can be recorded to included 2GB SD card. Connect up to four cameras for even more coverage!

- Kit includes DVR receiver with mains adaptor, remote control, camera sensor light with rechargeable Li-ion battery, solar panel and USB and AV cables
- Solar charged camera
- DVR size: 207(L) x 92(W) x 77(D)mm

QC-3644

NEW $299.00

Spare camera available separately
QC-3646 NEW $199.00

Speakers with Docking Station

Portable, versatile and suitable for use in a small room or on the go. Simultaneously charges the iPhone/iPod® when mains powered.

- Dual 2" full range drivers
- Requires 4 x AAA batteries
- Size: 256(W) x 115(H) x 70(D)mm

AR-1889 ***was $69.95***
Note: iPhone® not included

$59.95 SAVE $10

Dual Battery Volt/Current Monitor

Don't let your battery run flat ever again! This digital battery monitor will check your main battery voltage and the total battery activity of your auxiliary battery. Excellent for boats or caravans/RVs, especially when running refrigeration products. 250A current shunt supplied.

- Front panel size: 72(W) x 65(H)mm
- Mounting hole: 2" or 52mm

MS-6176

NEW $149.00
DUE EARLY AUGUST

5.8GHz HDMI Sender/ Receiver - 1080p

Wirelessly pipe a 1080p HDMI source to a HDTV in another room. Saves you the hassle of installing wallplates, crawling into wall cavities, or running messy cable around the house. Comes with IR remote control.

- Range: up to 25m
- Includes IR extender function
- Receiver/sender size: 154(H) x 92(W) x 20(D)mm

AR-1877 ***was $249.00***

$229.00 SAVE $20

Spare receiver Limited stock. Not available online
AR-1876 ***was $149.00 now $129.00 save $20***
4-input HDMI Switcher
AR-1874 ***was $49.95 now $39.95 save $10***

Network 8 Channel DVR with 4 High Grade CCD Cameras

This expandable surveillance kit contains an 8 channel DVR, 4 high grade CCD 650TVL cameras, camera cables, and power supply. The included CCD cameras are 960H compatible and give superior video quality both day and night. Supplied with 500GB of storage capable of recording up to 200 hours of continuous video. By connecting the DVR to your computer network, video can also be viewed remotely via using a web browser or iPhone®/Smartphone application.

- H.264 video compression
- HDMI connection
- Motion trigger recording
- 650TV lines camera
- Size: 300(W) x 220(D) x 50(H)mm

QV-3036

NEW $899.00

Spare cameras QC-8634 NEW $149
Also available: ***Stand Alone 8 Channel DVR*** QV-3037 NEW $499.00

To order call 1800 022 888 www.jaycar.com.au

In-Car Quick Chargers

- 12-24VDC input
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Quick Charger for iPhone 5® and iPad®

Suitable for charging the latest Apple® brand gadgets such as iPhone 5® and iPad®, which have the new Lightning™ connector socket.

- Lead length: 900mm

MB-3668 NEW $14.95

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Suits Smartphones and Tablets using the USB Micro-B socket for charging.

- Lead length: 900mm

MB-3669 NEW $14.95

UHF 5dBi Fibreglass Antenna

This high-gain antenna means a real radiated power increase and improved reception. Suitable for all truckies, buses, RVs, cars etc using standard UHF CB. The antenna is fibreglass and it features a flexible spring base to absorb and deaden the vibrations associated with driving.

- Frequency: 477MHz for UHF
- Cable length: 5m
- Termination: PL259
- Size: 630(L)mm

DC-3078 NEW $79.95

Also available:

Bull Bar Bracket - DC-3077 NEW $14.95

Allows you to attach an antenna to your vehicles bullbar to improve reception.

12V Siren with Multiple Selectable Sounds & Microphone

Perfect for sports carnivals, school fairs, or to add a bit of flair to your car horn. Features 5 animal sounds (cow, dog, horse, cat, rooster) and 5 different siren tones. It also comes with a microphone so doubles as a powerful PA system.

- 12V powered
- Controller size: 135(L) x 117(W) x 38(H)mm
- Speaker size: 115(L) x 97(Dia.)mm

LA-5262 NEW $44.95

JAYCAR - No. 1 for Kits 50W Amplifier Module Kit

Ref: Silicon Chip Magazine March 1994

This 50W unit uses a single chip module and provides 50WRMS into 8 ohms with very low distortion and extreme quietness. PC Board size only 84 x 58mm. See website for required power supply components.

- Power requirement: +/-35VDC rails @ 80VA per module
- PCB: 84 x 58mm

KC-5150 $29.95

Transmitter/Charger/Gooseneck In-Car Holder

The bracket holds an iPhone 5® in place and charges it through the Lightning™ connector. The unit connects to 12V or 24V power via the cigarette lighter socket.

- Aux. USB port: 5V 0.8A
- Built-in FM transmitter
- Gooseneck/swivel bracket
- Size: 110(H) x 65(W) x 40(D)mm

AR-3125 NEW $49.95

iPhone® not included

3-in-1 Jump Starter - Work Light - 12V Power Pack

This model is perfect for getting a car, motorbike, or a light truck back up and running when the battery goes flat. It features a powerful 17Ah battery, worklight for night time use, a reverse polarity indicator as well as a battery power indicator.

- Includes mains adaptor and cigarette lighter charging cable
- LED battery level indicator
- Size: 285(H) x 251(W) x 130(D)mm

MB-3692 NEW $99.95

In-Car DAB+ Receiver with FM Transmitter

This is a full DAB+ Receiver that will connect to your car audio system via an FM band transmitter or a 3.5mm stereo audio plug (many new car head units have a 3.5mm input). Features radio stabilisation technology to ensure good reception at high speeds as well as a USB socket with adaptors to charge Smartphones and Tablets.

- 35mm (1.44") colour TFT display
- Included adaptors: USB Micro-B, USB Mini, Nokia plug
- Size: 190(L) x 66(W) x 60(D)mm

AR-1902 $119

To see if digital radio is available in your area visit digitalradioplus.com.au

USB Port Voltage Checker Kit

Ref: Silicon Chip Magazine July 2013

An easy way to test a USB port to see if it is dead, faulty or incorrectly wired to help prevent damaging a valuable USB device you plan to connect. Voltage is indicated using three LEDs. Kit supplied with double sided, soldermasked and screen-printed PCB with SMDs pre-soldered, clear heatshrink, USB connectors and components for USB 2.0 & 3.0.

- PCB: 44 x 17mm

KC-5522 NEW $29.95

Car Battery Monitor

Simply plugs into your car's cigarette lighter socket and indicate alternator and battery status. Compatible with 12VDC systems.

- Size: 85(L) x 75(W) x 15(D)mm

PP-2142 NEW $9.95

OBD2 Memory Saver Lead

Prevent your car's ECU from having to re-learn its settings. Use this OBD2 memory saver lead to store, and restore all of your fault codes, radio settings, alarm settings, keyless entry codes, and more.

- Compatible with most post-1996 vehicles fitted with an OBD2 port
- Length: 1m

PP-2140 NEW $12.95

12V Leads with SAE Type Plugs

A range of SAE leads for your car or motorbike. Designed to prevent short circuits if the exposed plug makes contact with any part of the car.

SAE Plug to Battery Terminal Fused Lead PP-2012 $9.95

SAE Plug to Cigarette Lighter Plug Lead PP-2014 $9.95

SAE Plug to Cigarette Lighter Socket Lead PP-2016 $9.95

PP-2016 NEW $9.95 each

15A Cigarette Lighter Extension Lead - 3m

A heavy duty cigarette lighter extension lead to extend the reach of your 12VDC devices. Features internal fuse protection with LED power indicator. Fits all 12VDC plugs & sockets. Flexible curly cord design.

- Length: 3m

PP-2144 NEW $12.95

Mains Timer Kit for Fans and Lights $39.95

Ref: Silicon Chip Magazine Aug 2012

This simple circuit provides a turn-off delay for a 230VAC light or a fan, such as a bathroom fan set to run for a short period after the switch has been tuned off. The circuit consumes no stand by power when load is off. Kit supplied with PCB, case and electronic components. Includes 100nF capacitor for 1 min to 20 mins. See website for a list of alternate capacitors for different time periods between 5 seconds to 1 hour.

- Handles loads up to 5A
- PCB: 60 x 76mm

KC-5512

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/08/2013.

OUTDOOR

Powertech Portable 50L Fridge/Freezer

Using the renowned Danfoss® BD35F compressor and control module, this Powertech fridge/ freezer keeps your food and drinks fresh and cold with superb energy efficiency and reliability. It features a digital display control panel, an internal LED light, 3-stage battery protection, an internal food basket, separate dairy section, and tough external carry handles that double as tie down points.

- Powered by either 12-24VDC or 240VAC
- Uses just 0.7A per hour

50L Fridge GH-1604

Danfoss

NEW $825.00

ALSO AVAILABLE ONLINE OR BY SPECIAL ORDER IN-STORE

30L Fridge GH-1600 $695.00

40L Fridge GH-1602 $749.00 30L/40L not available in all stores!

LED Roof Lamp with Switch

A fixed installation roof lamp suitable for a caravan, boat, truck, or even a car. The LEDs sit behind a diffuser to help spread the light evenly.

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12 LED 280 Lumens SL-3460 $44.95
- 404mm long

30 LED 320 Lumens SL-3461 $69.95
- 398mm long

NEW FROM $44.95

Multi-Function Dynamo Torch with Igniter

This torch is also a mobile phone charger, compass, whistle, and a windproof igniter for starting camp fires. Simply crank the dynamo handle to generate power.

- 105mm long

ST-3341

NEW $19.95

LED Gooseneck Lamp

Featuring a sturdy 300mm gooseneck with screw-down base at one end and 9-LED luminaire at the other. Once the base is fixed the gooseneck can be swivelled at almost any angle.

- Wall or desk mount
- 12V powered
- 9 x Cool White LED
- 75 Lumens
- Size: 400(L) x 50(W) x 35(H)mm

SL-3473 Stock will be in white colour

NEW $19.95

Corner Strip LED Lamps

Corner strip lamps for a carvan or boat. The high brightness LEDs are encased in an opaque diffusing channel and include mounting holes on either end.

NEW FROM $14.95

- 12V

6 x White LED 65 Lumens SL-3463 $14.95
- 210mm long

12 x White LED 140 Lumens SL-3465 $24.95
- 410mm long

"Gas Mantle Look" LED Tent/Indoor Lamp

This compact lamp opens to reveal a lampshade-like diffuser equipped with a powerful 1W LED. It collapses flat and can also be used as a flashlight. Battery operated.

- Requires 3 x AA batteries
- Size: 85(Dia.) x 45mm (collapsed)

SL-2717

NEW $14.95

Roof Mount Interior LED Lamp

Simple to install and use LED roof lamp for your motorhome, truck, or boat. Features 12 high brightness cool white LEDs and a on/off switch.

NEW $24.95

- 140 Lumens
- Size: 185(L) x 126(W) x 25(H)mm

SL-3452

Outdoor Surveillance Cameras

Versatile economical surveillance cameras with IR illumination, designed for quick and easy installation in domestic and small business surveillance systems.

- Each camera supplied with power supply and combined 1.8m video and power cable.

CMOS Dome Camera with IR Illumination

- 380TV lines, colour
- Size: 100(Dia.) x 70(H)mm

QC-8635

NEW $59.95

High Resolution CMOS Dome Camera with IR Illumination

- 600TV lines, colour
- Size: 110(Dia.) x 85(H)mm

QC-8633

NEW $99.00

High Grade CCD Cameras with IR Illumination

Available as an indoor dome or weatherproof outdoor model, both feature CCD sensors and built-in IR LEDs so you can be sure to capture good quality video day or night.

- 12VDC
- 650TV lines

Bullet Camera
- Size: 145(L) x 85(H) x 68(W)mm

QC-8634 $149.00

Dome Camera
- Size: 120(Dia.) x 90(H)mm

QC-8636 $149.00

NEW $149.00 ea

Battery Operated Camping Shower

Use it almost anywhere. Drop the submersible pump into a clean water supply (a bucket will do), hang the shower head in a convenient location, and you're ready to wash!

- Requires 4 x D batteries
- Hose length: 2.5m

YS-2802

FREE 4 x D Eclipse Batteries worth $7.50 (SB-2321)

$39.95

3W Gymbal LED Spotlight

A flush mount LED spotlight suitable for caravans and boats. It produces a bright cool-white light in a gymbal mount/bracket for optimum angle.

- 12V or 24VDC
- 1 x 3W Cool white LED
- 165 Lumens
- Requires 52mm Dia. cutout (plus small hole for switch)

SL-3472

NEW $34.95

Marine Switch Panels with Circuit Breakers

Can be mounted either vertically or horizontally. 10A, 8A, 6A and 4A rated circuit brakers. Soldered to a 10A rated illuminated rocker switch which have 4.8 QC tabs and are single pole.

NEW FROM $29.95

4 Way SZ-1902 $29.95
- Size: 110(H) x 100(W) x 45(D)mm

6 Way SZ-1903 $39.95
- Size: 160(H) x 100(W) x 45(D)mm

IP66 Marine Switch Panels with Circuit Breakers

The panels have Butyl rubber gaskets and are waterproof from the front. The 4 way has 6,10,15 & 20A rated circuit breakers and the 6 way has 6, 6,10,10,15 & 20A breakers.

NEW FROM $59.95

4 Way SZ-1906 $59.95
- Size: 120(H) x 130(W)mm

6 Way SZ-1907 $79.95
- Size: 170(H) x 130(W)mm

LCD Monitor Articulating Brackets

Sleek and functional LCD brackets for your home or office desk to free up space and to give greater flexibility to your monitor position. They feature attractive articulating arms that will allow you to tilt the monitor up 90°, down 45°, pan it 180°, and rotate the monitor around a 360° range.

- Suits monitors up to 27"

Desk Mount Bracket CW-2872 $99.00

Wall Mount Bracket CW-2873 $89.95

NEW FROM $89.95

Hard Drive Dock with Cloud Access

Allows you to store and access files on your network or across the Internet using a web browser or Smartphone. Features USB 3.0 & Ethernet, media server with UPnP & iTunes® support, network file server, and more. See website for full list of features and setup options.

- Supports 3.5/2.5 inch SATA hard drives
- Size:134(L) x 114(W) x 55(H)mm

XC-4691 ***was $119.00***

$99.00 SAVE $20

Note: HDD not included, and requires freely available third-party app for Smartphone support.

Sync/Charge Lead for Galaxy Tab - 1m

Sync/charge lead to suit Samsung Galaxy® Tab.

- Length: 1m

WC-7680

NEW $9.95

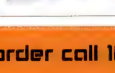
DUE EARLY AUGUST

Component/Composite Video to VGA Converter

This compact converter box accepts a range of video input signals and converts them to VGA specification for use on CRT, LCD, etc. Also accepts YPbPr input for DVD players, Xbox®, Wii®, or other video sources up to 1080i. Simple on-screen set up. No software required. Includes remote control.

- Size: 90(D) x 145(W) x 24H)mm

XC-4873 ***was $69.95***



$59.95 SAVE $10

Limited stock. Hurry!

FME Adaptor for Samsung S2/S3*

For connecting your Samsung Galaxy S2/S3® to an antenna for improved reception on 3G and 4G networks.

AR-3319

NEW $16.95

Also available:

FME Adaptor for Telstra 4G USB Modem AR-3320 NEW $16.95

Bluetooth® Audio Receiver

Simply plugs into a suitable iPhone® or iPod® speaker dock to give quality amplified stereo sound from a Bluetooth® fitted phone (Blackberry®, iPhone®, Samsung, HTC etc.) from up to 20m away.

- Fitted with 30 pin Apple® connector
- Size: 46(L) x35(W) x 17(H)mm

AA-2084

NEW $34.95

Slimline Laptop Power Supplies

These 19V slimline power supplies suit a variety of ultrabooks, laptops and netbooks that require 18-20V. Features a USB port for charging a Tablet or Smartphone. See website for specifications and compatibility.

65W Universal

- Plugs: 7
- Size: 113(L) x 56(W) x 15(H)mm

MP-3321 $49.95

120W Universal

- Plugs: 8
- Size: 123(L) x 75(W) x 19(H)mm

MP-3329 $89.95

DUE EARLY AUGUST

NEW FROM $49.95

USB Power Bank

Simply connect your phone or other mobile device for a quick charge. It features a USB charging port and lead with 3 connectors for charging all variety of Smartphones, USB devices and some Tablets.

- 2600mAh Li-ion battery
- Size: 76(L) x 33(W) x 29(D)mm

MB-3642 ***was $34.95***

$29.95 SAVE $5

6-in-1 Card Reader for iPad®

Plug the memory card reader into your iPad® and easily transfer photos to it from your memory cards.

Card Reader for iPad® 1/2/3

- Suits 30-pin connector

WC-7714 $14.95

Card Reader for iPad®/Mini iPad®/iPad® with Retina Display

- Suits Lightning™ connector

WC-7716 $24.95

NEW FROM $14.95

DUE EARLY AUGUST

4-in-1 Magnetic Charging Hub

An extremely convenient and attractive mains charger for your Smartphone or MP3 player. Magnetic connectors make it easy to connect and disconnect device.

- Includes 30 pin iPhone® connector, Mini USB, Micro-B USB, Nokia connector
- Mains adaptor included
- Size: 80(Dia.) x 15(H)mm

MB-3651

iPhone® not included

NEW $49.95

2 Port KVM Switch

Share a stereo speakers, mic, keyboard and mouse across two computers. Connect to a HDMI or DVI input screen. Easily switch between the two at the press of a button. No external power necessary.

- Can support up to 2 x USB2.0 hubs
- Transmission distance: PC up to 5m, console up to 3m
- Size: 100(L) x 75(W) x 23(D)mm

YN-8094

$119.00

GRAB-A-BARGAIN!

USB Business Card Scanner

Powered by USB and uses a 2MP sensor with fixed focus to capture clear images. Includes Optical Character Recognition software that extracts text from the business card. Doubles as a webcam with microphone.

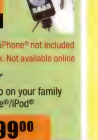
- Size (folded): 95(L) x 37(W) x 14(D)mm

QC-3130 ***was $49.95***

$39.95 SAVE $10

Smart Digital Pen

Write or sketch on paper and see it displayed on your iPad® or iPhone® screen! Stores up to 100 pages in the memory.



- Saves digitally in real time
- Can be used standalone
- MAC and PC compatible

XC-0359 ***was $139.00***

$99.00 SAVE $40

iPhone® not included

Limited stock. Not available online

Wi-Fi Controlled Rover

Have endless hours of fun, sneaking up on your family and friends with our Wi-Fi iPad®/iPhone®/iPod® controlled Rover. Features a built-in microphone for live audio streaming, onboard camera for live video stream or to take snapshots.

- Range up to 60m
- Requires 6 x AA batteries
- Size with antenna: 196(L) x 260(W) x 196(H) mm

GT-3598 ***was $119.00***

$99.00 SAVE $20

Limited stock. Not available online

iPad® not included

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/08/2013.

Jaycar Electronics
Better, More Technical!

GRAB-A-BARGAIN

4 Channel DVR with 4 High Resolution CCD Cameras

View live and/or recorded footage anytime, anywhere! Contains multiplexing DVR with Ethernet access, four weatherproof CCD cameras with IR illumination, and four 20m cables.

- 704 x 576 D1 resolution @ 100fps
- 500GB SATA Hard disk
- 520TV line cameras
- CCD cameras provide clearer images at night time
- DVR size: 343(W) x 240(D) x 68(H)mm

QV-8108 ***was $649.00***

$549.00
SAVE $100

500GB HDD INCLUDED

Add this 17" Monitor for $150 (QV-3106)

Monitor also sold separately (QM-3577)

8" Colour LCD Doorphone System with 4-Channel Recording

The 8-inch, high resolution LCD screen connects up to two intercom/camera units and has a built-in DVR with four camera input. The monitor can display a multi-way split screen view, or auto-switch between channels. Supports manual, motion detection, visitor call and loop coverage recording functions and also features remote access over Ethernet or Internet.

- Mains power supply included
- Monitor size: 210(H) x 250(W) x 35(D)mm

QC-3628 ***was $549.00***

$499.00
SAVE $50

Limited stock.

500GB HDD INCLUDED

Additional security cameras also available
QC-3629 ***was $79.00 now $59.00 save $20.00***

5-in-1 Jump Starter-Inverter-Charger-Compressor-Work Light

Your personal roadside assistant! Includes heavy duty insulated jumper leads, a 400W inverter, LED work light, 12V power outlets, status gauges, and even a 260PSI air compressor! Powered from the built-in 18Ah SLA battery and comes with mains and 12V charging cables.

- Size: 270(L) x 215(W) x 295(H)mm

MB-3594 ***was $149.00***

$119.00
SAVE $30

Limited stock.

Weather Station/Clock/Photo Frame

A remote sensor sends data to the display unit, which provides temperature, humidity, trend and forecast information and also displays indoor temperature. Photos can be loaded by a host PC, via SD/MMC card or USB flash drive. Mains plugpack included.

- 12/24 hour clock with alarm
- Time and date display with DST and time zone
- Wall or desk mount
- Size: 200(W) x 150(H) x 30(D)mm

XC-0345 ***was $99.00***

$89.00
SAVE $10

Mini FM Radio with MP3 Player

Compact and portable, listen to songs on the go or share with others. It's rechargeable so there's no need to buy batteries. Simply charge via USB using the supplied cable.

- 2WRMS mono speaker
- Size: 91(W) x 54(H) x 20(D)mm

AR-1738

BUY 2 for $25 SAVE $4.90

$14.95

2.4GHz DIGITAL Wireless Speakers

$119.00
SAVE $10

The 2.4GHz audio transmitter pipes a crystal clear audio to the units up to 30m away. Powered by included mains adaptor or 12 x AA batteries (not included).

- Audio and USB cables included
- Speaker size: 250(H) x 130(Dia.)mm

AR-1891 ***was $129.00***

Be REWARDED for your love of electronics

As a way of saying thank you – everyday – we've put together a loyalty programme called Jaycar Rewards. It's for our regular customers who love DIY everything electronic!

The Jaycar Rewards programme will entitle you to accumulate one point with every dollar spent* at any Jaycar Store* and be rewarded with a $25 Rewards Cash Card once you reach 500 points.

Register online today by visiting www.jaycar.com.au/rewards or www.jaycar.co.nz/rewards

*Conditions apply, company stores only and only available for retail Transactions in Australia and New Zealand. See website for full terms and conditions.

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Arrival dates of new products in this flyer were confirmed at the time of print but delays sometimes occur. Please ring your local store to check stock details.
Prices valid from 24th July 2013 to 23rd August 2013.

Occasionally there are discontinued items advertised on a special / lower price in this promotional flyer that has limited to nil stock in certain stores, including Jaycar Authorised Stockist. These stores may not have stock of these items and can not order or transfer stock.

HEAD OFFICE
320 Victoria Road, Rydalmere NSW 2116
Ph: (02) 8832 3100 Fax: (02) 8832 3169

ONLINE ORDERS
Website: www.jaycar.com.au
Email: techstore@jaycar.com.au

Jaycar Electronics
Better, More Technical!

12VDC Touch Switch Controller

Add up to three sleek and unobtrusive touch switches to control 12VDC LED lighting in your caravan, car, or boat. Each switch controls the same device.

- 3A rated
- 6W standby
- Size: 59(L) x 39(W) x 13(H)mm
- Touch switch wire length: 150(L)mm ST-3942

NEW $29.95

Also available:
12VDC Switch Controller with PIR Sensor
ST-3940 NEW $19.95

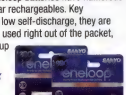
CLEARANCE on Inverters

Range in power from 180 to 2000 watts and provide stable and reliable power in mobile and permanent installations. Pure sine wave inverters are recommended for products with sensitive electronics, timers or motor powered devices. See website for full specifications.

- 12V input

180W	MI-5160	*was $189*	*now $139*	*save $50*
380W	MI-5162	*was $239*	*now $179*	*save $60*
600W	MI-5164	*was $349*	*now $259*	*save $90*
1000W	MI-5170	*was $599*	*now $449*	*save $150*
1500W	MI-5172	*was $899*	*now $674*	*save $225*
2000W	MI-5176	*was $1199*	*now $899*	*save $300*
*2000W**	MI-5174	*was $1199*	*now $899*	*save $300*

*24V input
Limited Stock.
Models MI-5164 & MI-5176 are not available online.



FROM $139.00

25% OFF SELECTED PURE SINE WAVE INVERTERS

Sanyo Eneloop Ni-MH Pre-Charged Batteries

This range of Sanyo eneloop batteries have numerous advantages over regular rechargeables. Key characteristics include low self-discharge, they are pre-charged so can be used right out of the packet, and can be recharged up to 1800 times.

1.2V 2000mAh AA 2 Pk
SB-2930 $14.95
1.2V 2000mAh AA 4 Pk
SB-2931 $24.95
1.2V 800mAh AAA 2 Pk
SB-2932 $14.95
1.2V 800mAh AAA 4 Pk
SB-2933 $24.95

NEW FROM $14.95

Ni-Cd/Ni-MH Battery Charger

An affordable universal battery charger that will re-charge Ni-MH/Ni-Cd batteries in AA, AAA, C, D as well as 9V. It will also ensure long battery life by cutting-off the voltage when they are fully charged.

- Mains powered
- Size: 199(L) x 100(W) x 46(H)mm MB-3514

Batteries not included

NEW $24.95

Grid-Connect Solar Power Monitor with USB interface

Measures the power consumption of your home, the power being produced by your solar array, and also gives you a "balance" of the power you are consuming versus what your solar array is producing. It displays the costs and a feed-in tariff for your solar production.

- Uses 433MHz to wirelessly transmit data
- Displays solar power, household power, overall power & costs
- Stores up to 2 years of data

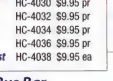
MS-6167 *was $149.00*

$139.00 SAVE $10

NOTE: Only works with NET-METER grid-connect solar systems.

Universal Brass Battery Terminals

Heavy duty solderless range of marine grade battery terminals.



NEW $9.95 each

HC-4030

Saddle Type	HC-4030	$9.95 pr
End Entry single bolt	HC-4032	$9.95 pr
Lug Bolt Style	HC-4034	$9.95 pr
Barrel 2-Bolt side entry	HC-4036	$9.95 pr
Isolating Type - Negative post	HC-4038	$9.95 ea

150A Insulated Bus Bar

This quality bus bar features a raised insulating base that isolates the bus bar from earthed or other live chassis. Suitable for 12-32V wiring with total current capacity of 150A.

- Size: 145(L) x 30(W) x 40(H)mm

SZ-2012

Note: Not mains rated

NEW $14.95

120W 12V Monocrystalline "Narrow" Solar Panel

The same power as the more typical size 120W solar panel, but in a more narrow footprint (around 150mm shorter) to fit over a smaller surface area.

ZM-9087

- Max. power: 120W
- Rated voltage: 12V
- Weight: 10kg
- Size: 1190(H) x 660(W) x 35(D)mm

ZM-9085

NEW $329.00

145W 12V Monocrystalline Solar Panel

With the increases in silicon solar panel efficiency, we are now able to offer this 145W rated solar panel with the same physical dimensions as a typical 120W solar panel. Excellent for caravan, marine, or other applications where space is limited.

NEW $369.00

- Max. power: 145W
- Rated voltage: 12V
- Weight: 12kg
- Size: 1250(H) x 808(W) x 35(D)mm

ZM-9087

POWERTECH

3 Stage 48V 9A Battery Charger

Monitors and manages your charging with three different stages and maintains the optimum charge level. Compact and lightweigh. Cables included.

- Switchable charging modes
- Short circuit, output current, polarity and thermal protection
- Size: 298(D) x 112(W) x 60(H)mm

MB-3628 *was $199.00*

$149.00 SAVE $50

Battery Switches with Enclosure

Simple 2 and 4 position battery switches for controlling battery power on your boat. Ideal if you have one battery for starting the engine and another for auxiliary electrical equipment. Durable design.

2-Position - SF-2246
- Continuous rating: 275A

NEW $29.95

4-Position - SF-2248
- Continuous rating: 175A

NEW $39.95

Adjustable Universal Battery Hold Down Clamp

Universal battery clamp which adjusts to suit batteries ranging from 135-190mm width and 150-230mm height.

- Metal construction with wing nut adjustments

HC-4039

NEW $9.95

8-Way Powerboard

Protect your home theatre and sensitive high-end gear. With surge protection, filtering and a built-in circuit breaker for 8 mains outlets, this powerboard also has telephone protection (1 input, two outputs so doubles as a splitter), data/network connection, satellite/cable TV, and TV antenna. See website for more info.

- 8 surge and spike protected outputs

MS-4029 *was $79.95*

$69.95 SAVE $10

TOOLS & MONITORS

Multi-Function Tools

7 in 1 Pocket Tool

With 2 knives, 2 can/bottle openers, spring-loaded scissors, a standard screwdriver and a trusty corkscrew, this great tool is the answer to all your outdoor needs.

- Size: 99(L) x 23(W) x 19(H)mm

TH-1924

NEW $9.95

DUE EARLY AUGUST

Note: Age restrictions apply on knife sales in some states.

Survival Knife

Suitable for a variety of outdoor activities and emergency situations. Effortlessly extract the blade with one hand using the liner lock system.

- Blade features straight and serrated edges
- Built-in LED light/fire starter/ belt cutter/window breaker
- Size: open: 208(L)mm closed: 126(L)mm

TH-1925

NEW $14.95

DUE EARLY AUGUST

Note: Age restrictions apply on knife sales in some states.

12 in 1 Tool

Consisting of a file, bottle/can opener, a saw, scissors, a small and large knife, 3 sized standard screwdrivers, a Philips head screwdriver and needle nosed pliers, this tool is a must for any explorer. Includes carry pouch.

- Size: 99(L) x 43(W) x 18(H)mm

TH-1926

NEW $24.95

DUE EARLY AUGUST

Note: Age restrictions apply on knife sales in some states.

Wireless In & Out Thermometer and Hygrometer

Capable of measuring humidity, indoor and outdoor temperature. The large easy to read LCD acts as a receiver unit for a separate outdoor sensor unit. It will record max and minimum temperatures for quick referral and displays the time of day.

- Receiver requires 2 x AA alkaline batteries
- Remote requires 2 x AAA alkaline batteries
- Receiver size: 95(H) x 114(W) x 25(D)mm
- Sensor size: 51(H) x 63(W) x 25(D)mm

XC-0322

NEW $29.95

Additional sensor available separately

XC-0324 NEW $14.95

Heat Index Monitor

Not only it measures temperature and humidity it shows on a simple scale just how dangerous the environment is around you.

- Heatstroke alert on 4 levels
- Colour change denoted elevated danger
- Displays ambient temp, humidity
- Requires 2 x AAA batteries
- Size: 30(L) x 59(W) x 90(H)mm

QM-7311

NEW $24.95

31 Piece Mini Tap & Die Set

This 31 piece set is for the ultra small screws found in electronics. The kit consists of 9 metric screw cutting dies and 18 equivalent taps in the same sizes but with a taper and a plug version of the tap. Supplied in a see-through plastic case.

- Size: 83(W) x 153(L) x 12(D)mm

TD-2443

NEW $59.95

Easy Coax Cable Stripper

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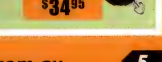

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Charge any iPod using a standard 5V plugpack & this simple circuit

iPod Charger Adaptor

By JOHN CLARKE

This simple iPod charger adaptor uses just a few parts and mates with a standard 5V switchmode plugpack or a standard USB supply/charger. If you already have a 5V plugpack, it will cost you less than a proprietary charger and is easy to build.

WHILE iPODs can be charged via a computer USB port, this is not always convenient and a separate charger is more useful. That way you can charge from the 230VAC mains or from a USB power outlet that plugs into the lighter socket of a car. However, iPod chargers from Apple and other suppliers can be expensive, while low-cost chargers bought online might not work with some iPod models.

Generic USB plugpack supplies and chargers are much cheaper but they won't work with iPods. Instead, you will be left with a "charging is not supported with this accessory" warning. However, with just a few minor additions, you can get a generic 5V supply/charger to work.

Back in February 2006, we published an iPod Charger that comprised a 5V switchmode regulator fed from a 9-15V DC plugpack and the output was via a USB socket. It was designed to charge the first generation (1G) iPod nano available at the time. Later, we published modifications to enable the charger to work with subsequent iPod releases from Apple.

Essentially, four resistors have to be added across the 5V supply to provide a DC voltage at the D+ and D- (data lines) of the USB socket. These are required for iPods to recognise the charger as valid before charging occurs.

Now in 2013, an iPod charger can be much simplified. We can just use a cheap 5V regulated plugpack or USB supply or charger directly. Add a USB socket and some resistors to set the voltage at the D+ and D- inputs on the USB socket and that's all that is required.

Circuit details

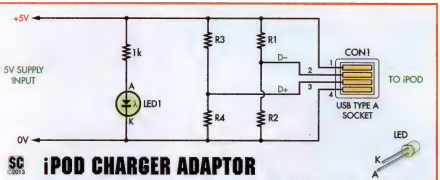
Fig.1 shows the circuit. The 5V supply connects to the 5V and 0V terminals, ie, pins 1 and 4 respectively of the type "A" USB socket. Resistors R1 and R2 form a voltage divider network across the 5V supply for the D- (Data minus) input while R3 and R4 set the voltage for the D+ input. A 1kΩ resistor provides current limiting for the power LED (LED1). We used a blue LED but any colour could be used including red, green, yellow, orange, white and aqua.

Construction

The parts are assembled onto a PCB coded 14108131 and measuring 18 x 60mm. Fig.2 shows the layout details. Install the resistors first, checking the values as you go with a digital multimeter. Table 1 shows the values for resistors R1-R4 to suit different iPod modelss (and for the Samsung Galaxy Tab2), while Table 2 also shows the resistor colour codes.

It's just a matter of selecting the resistors to suit your particular device.

We recommend that these resistors are only tack-soldered in first and the charger adaptor tested before fully soldering the resistors directly onto the PCB. Make sure that the supply



iPOD CHARGER ADAPTOR

Fig.1: the circuit uses just a few resistors, a power indicator LED and a type "A" USB socket. Power comes from a regulated 5V plugpack supply.

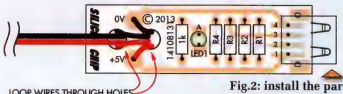


Fig.2: install the parts on the PCB as shown in this diagram. Resistors R1-R4 are selected from Table 1 to suit the iPod model.

This view shows the completed PCB. Make that sure the LED is orientated correctly.

Parts List

1 PCB, code 14108131, 18 x 60mm
1 5V 1A regulated plugpack (eg, Jaycar MP3144, Altronics M8903) OR
1 5V USB charger/supply and 1 USB "A" line plug (Jaycar PP-0790) with a length of light-duty figure-8 wire OR
1 USB type "A" plug & cable cut from a USB extension lead
1 PCB-mount USB type "A" socket (Jaycar PS0916, Altronics P1300)
1 75mm-length of clear 20mm diameter heatshrink tubing
1 3mm LED (any colour) (LED1)

Resistors (0.25W, 1%)

1 33kΩ	2 15kΩ
2 22kΩ	1 10kΩ
1 18kΩ	1 1kΩ

you will be using can deliver the necessary current if you want to charge at 500mA or 1A.

The LED indicator is mounted directly on the PCB. Make sure it is orientated correctly with the anode (longer lead) inserted as shown on Fig.2. Solder its leads quickly to avoid heat damage.

The USB socket goes in last. It must be pushed right down onto the PCB before soldering its outer mounting lugs soldered. Its four pin connections can then be soldered.

The 5V power input can come from either a 5VDC plugpack or a USB supply (eg, a plugpack with a USB socket). As shown, the leads from a plugpack are directly soldered to the 5V and 0V terminals after the wires have been looped through two holes at one end of the PCB. This is done to provide stress relief for the connections.

Make sure the that the plugpack's leads are connected to the correct pads. If in doubt, check the voltage between its leads before making the connections.

If you intend using a USB supply, a cable fitted with a USB type "A" plug at one end will have to be wired to the PCB. Fig.3 shows the details.

Note that we do not mean using a USB supply on a computer here, since all iPods can be charged from a computer USB port. However, USB ports on a charger are different in that they supply power via pins 1 and 4 of the USB socket but there is no communication via the D+ and D- lines.

Making the USB cable

You can obtain a suitable cable by cutting off the socket from a USB extension cable (ie, the socket at the opposite end of the cable to the type "A" plug). That done, strip back the insulation and connect the red wire to the +5V input on the PCB and the black wire to the 0V input. The unused white and green data wires must be cut short and insulated so they can not short to each other or to any other parts. Table 2 shows the wire colours in a USB cable.

Alternatively, you can use a USB

Table 1: Selecting Resistors R1-R4

iPod touch/iPHONE/ iPod NANO 2G	iPod touch/iPHONE (if product allows for 1A charge)	iPod Mini, nano 2G, Shuffle 2G	iPod Mini	iPod nano 1G and iPod Video 5G	Samsung Galaxy Tablet
D- @ 2V D+ @ 2V 500mA charge	D- @ 2.7V, D+ @ 2V 1A charge	D- @ >3V, D+ @ >3V 250mA charge (Mini and nano), 100mA (Shuffle)	D- @ 0V, D+ @ >3V 100mA charge	D- @ >3V, D+ @ 0V 500mA charge	D- @ 1.2V D+ @ 1.2V charge unknown or ≤1A
R1 = 22kΩ	R1 = 18kΩ	R1 = 22kΩ	R1 = 0mit	R1 = 22kΩ	R1 = 33kΩ
R2 = 15kΩ	R2 = 22kΩ	R2 = 0mit	R2 = 22kΩ	R2 = 0mit	R2 = 10kΩ
R3 = 22kΩ	R3 = 22kΩ	R3 = 22kΩ	R3 = 22kΩ	R3 = 0mit	R3 = 33kΩ
R4 = 15kΩ	R4 = 15kΩ	R4 = 0mit	R4 = 0mit	R4 = 22kΩ	R4 = 10kΩ

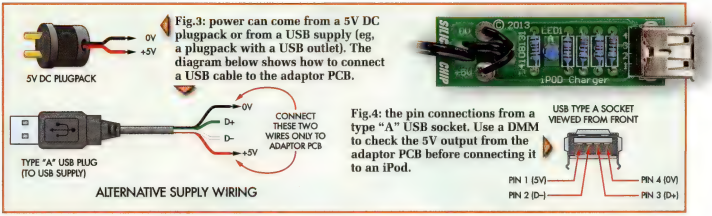


Table 3: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	33kΩ	orange orange orange brown	orange orange black red brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	1	18kΩ	brown grey orange brown	brown grey black red brown
❑	2	15kΩ	brown green orange brown	brown green black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	1kΩ	brown black red brown	brown black black brown brown

type "A" line plug (eg, Jaycar PP-0790) and connect this to the PCB via a length of light-duty figure-8 cable.

Checking output polarity

It's imperative that the output polarity from the adaptor is correct. This means that after connecting the iPod Charger Adaptor to a 5V supply, you should check the polarity at its USB output socket before connecting it to an iPod. In addition, if the incoming supply polarity is correct, then the indicator LED will be lit (provided it has been installed the right way around).

Fig.3 shows the pin connections as viewed from the front of the USB socket. Using a multimeter, check that pin 1 is at +5V and that pin 4 is 0V (both with respect to the 0V pad on the PCB).

Table 2: USB Cable Colours

Pin	Wire Colour	Name	Function
1	Red	V_{CC}	+5V
2	White	D-	Data -
3	Green	D+	Data +
4	Black	GND	Ground

When you are certain that the supply polarity (and voltage) is correct, the adaptor can be used with your iPod. You should be greeted by a charging indication when the iPod is plugged in. If charging does not take place or you get the "charging is not supported with this accessory" warning, check the iPod model that you have and check that the correct resistor values have been used for R1-R4.

Once everything is working, the resistors can be resoldered and the PCB covered in heatshrink tubing. If you do not have clear tubing, then used coloured heatshrink and cut a small slot in it for the LED to protrude through before shrinking the tubing down with a hot-air gun. SC

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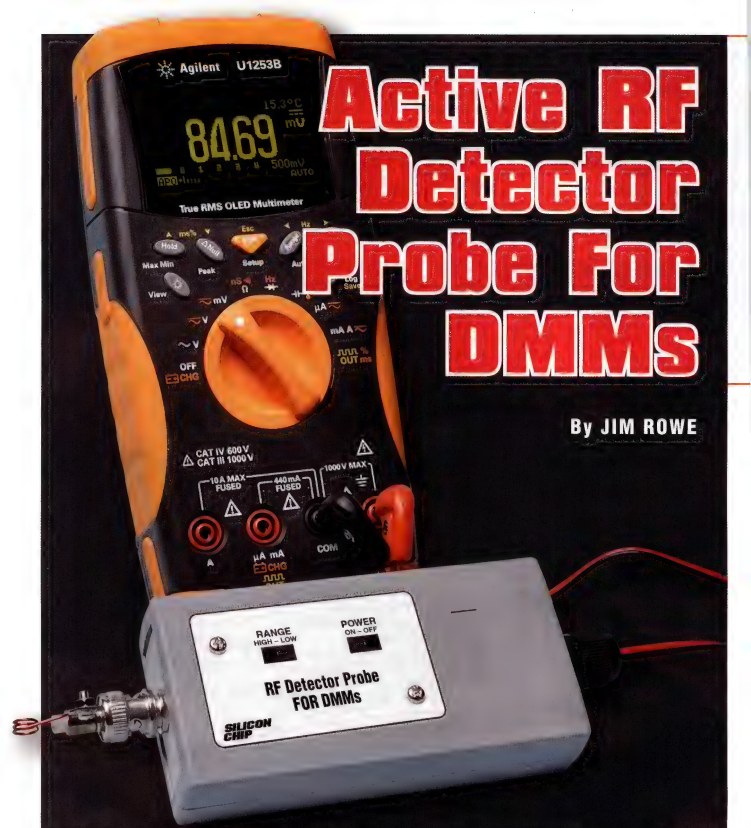
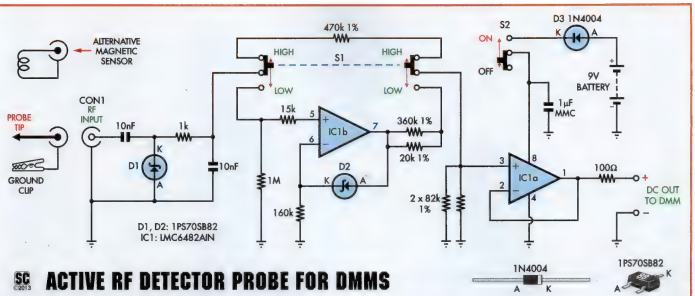


Active RF Detector Probe For DMMs

By JIM ROWE

This low-cost detector probe allows you to measure RF signals from below 100kHz up to over 1GHz with your DMM for signal voltages between about 20mV and 10V RMS. You can use it with a probe or a sniffer loop and you can even use it to measure the voltage across a coaxial cable load and calculate the RF power.



ACTIVE RF DETECTOR PROBE FOR DMMS

Fig.1: the circuit for the Active RF Detector Probe. When S1 selects the high range, the detected RF signal is rectified by D1, attenuated by a voltage divider and fed to voltage follower stage IC1a which then drives a DMM. Alternatively, on the low range, the detected signal from D1 is fed to IC1a via a linearity compensation circuit based on op amp IC1b.

IT'S NOT DIFFICULT to measure RF signals if you have access to an RF power meter or spectrum analyser but these are expensive instruments ($1500 plus). You simply can't justify their cost, unless you work a lot with RF and communications equipment. So what can you use to make the occasional RF signal measurement?

The usual approach is to use a passive RF detector probe connected to your DMM. By using a Schottky diode in the detector, these can give acceptable results for signals between about 500mV and 50V RMS, and between say 10MHz and 500MHz or so. But they're usually not much use for measuring signals below 500mV, due to non-linearity of the detector diode's forward conduction characteristic. Signals larger than about 50V also tend to be a problem, because of the diode's maximum reverse voltage rating.

Recently, I needed an RF detector probe that would be capable of measuring quite small signals – much lower than 500mV. I searched on the internet and found the circuit of an "active" RF detector probe using a nifty linearity compensation scheme developed originally by US radio amateur John Grebenkemper, KI6WX, for use in SWR bridges. This probe was claimed to be useful for measuring signals between 100kHz and 30MHz.

Experimenting with this circuit, I soon realised that its basic configuration could be refined to produce a version capable of working up to much higher frequencies. The result is the new design described in this article. It is capable of making measurements from below 100kHz to above 1GHz, for signals from about 20mV up to 10V RMS (in two ranges). It's low in cost, easy to build and particularly flexible in terms of the measurements it can make.

Circuit details

Fig.1 shows the complete circuit details for the probe. The actual RF detector diode is D1, a very tiny 1PS70SB82 UHF Schottky diode. It's connected in a standard half-wave configuration and produces a DC voltage across the 10nF filter capacitor that's very close to the peak value of the RF input signal.

When range switch S1 is in the HIGH position, this DC voltage is fed to the pin 3 input of op amp IC1a via a resistive voltage divider formed by a 470kΩ resistor and two paralleled 82kΩ resistors. The divider ratio is set so that the DC voltage fed to pin 3 of IC1a is equal to 0.0707 times the peak value of the input voltage, after allowing for losses in the detector, corresponding to one-tenth of the RMS value of the RF input.

Since IC1a (one half of an LMC6482 dual CMOS op amp) is connected as a voltage follower, this is the voltage fed out to the DMM.

Why do we attenuate the detector output by 0.0707 on this range and not just by 0.707, corresponding to the full RMS voltage of the RF input? It's because IC1 is operating from a supply voltage of about 8.4V (9V minus the 0.6V drop in D3), and so it can't handle signal levels greater than this. By dividing down by 10 as well, we allow the probe to measure signals up to the PIV (peak inverse voltage) rating of D1. This is 15V, corresponding to an RF input of 10.6V RMS.

So when the probe is switched to the HIGH range, the output of the detector diode is fed without any linearity compensation to IC1a, via the voltage divider. IC1a feeds this uncompensated DC voltage out to the DMM, merely lowering the source impedance so that accurate readings should be produced regardless of the DMM's input resistance. Most DMMs have an input resistance of 10MΩ or more on the DC voltage ranges, in any case.

On the HIGH range, the probe can measure RF signals between about 600mV and 10V RMS. The only complication on this range is that there's a built-in 10:1 division, so the DMM reads one-tenth the RMS value of the RF input signals, ie, 1.00V RMS becomes 100mV DC and so on.

Low range

Things get a little more interesting when you move range switch S1 to the LOW position. As you can see, this switches the 470kΩ divider resistor out of circuit and instead switches

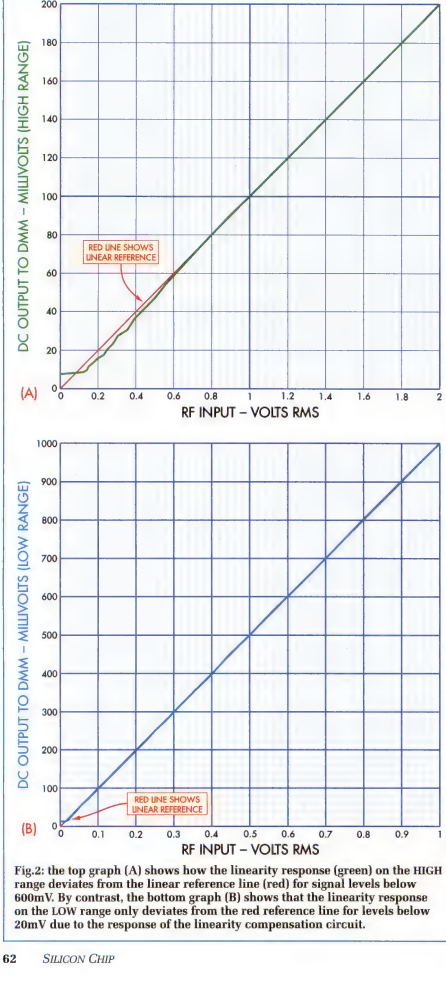


Fig.2: the top graph (A) shows how the linearity response (green) on the HIGH range deviates from the linear reference line (red) for signal levels below 600mV. By contrast, the bottom graph (B) shows that the linearity response on the LOW range only deviates from the red reference line for levels below 20mV due to the response of the linearity compensation circuit.

in a "linearity compensation" circuit based on IC1b and diode D2, another 1PS70SB82 Schottky diode.

IC1b is connected as a non-inverting amplifier stage, with D2 forming part of the negative feedback circuit – along with a 160kΩ resistor connected from pin 6 to ground. The combination of D2 and the 160kΩ resistor forms a non-linear voltage divider. This divider varies IC1b's gain according to the DC voltage level at its pin 7 output, in a manner that closely compensates for the non-linearity in detector diode D1.

As a result, the DC voltage at pin 7 is closely proportional to the peak level of the probe's RF input voltage, at levels right down to 20mV.

The paralleled 360kΩ and 20kΩ resistors connected from pin 7 of IC1b to the LOW side contact of switch S1 form the upper leg of an output voltage divider for this range, with the lower leg formed by the two paralleled 82kΩ resistors from pin 3 of IC1a to ground. The division ratio of this divider is arranged to make the DC voltage appearing at pin 3 of IC1a directly proportional to the RMS value of the RF input voltage, so that for this range the DMM reads the amplitude of the RF input signals directly.

Power for IC1 comes from a standard 9V alkaline battery, with diode D3 connected in series for reverse polarity protection. As the current drawn by IC1 is typically less than 2mA, the battery should last for almost its shelf life with intermittent use.

And that's all there is to the circuit operation.

Linearity performance

The performance you can expect from the Active RF Detector Probe can be seen in the linearity plots of Fig.2 and the frequency response plot of Fig.3. The upper plot (A) in Fig.2 shows the linearity at the lower end of the HIGH range and as you can see, it moves away from the linear reference line (red) at levels below 600mV.

By contrast, the lower plot (B) in Fig.2 shows the linearity at the low end of the LOW range. Here you can see that the DC output only deviates from the red linear reference line at RF levels below 20mV.

Fig.3 shows the measured frequency response of our prototype RF Detector Probe. It's quite flat, at about ±5% up to about 200MHz, then rises up to a peak at 500MHz and to an even larger peak

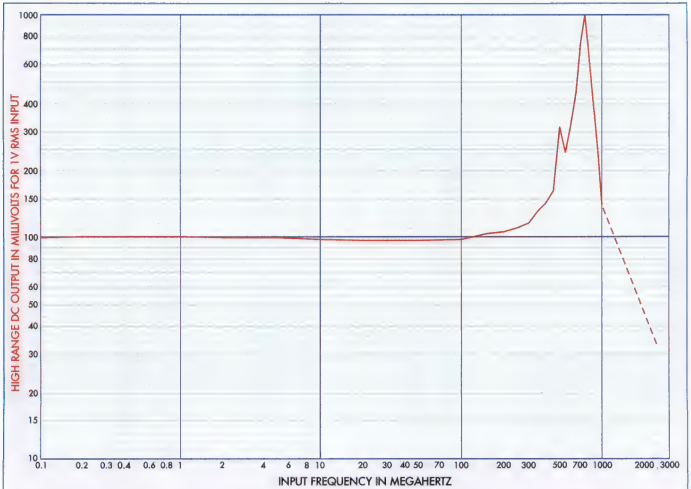


Fig.3: the frequency response of the prototype Active RF Detector Probe. It's quite flat up to about 200MHz but then rises steeply to peaks at 500MHz and 750MHz. Use this graph and the plots in Fig.2 to correct the measured RF voltage reading if necessary.

at 750MHz. These peaks are presumably due to resonances in the probe's input circuit (involving D1, the 10nF input coupling capacitor and input connector CON1) and would probably be very hard to remove.

D1, the 10nF capacitors and the 1kΩ resistor are all SMD components and D1 and the 10nF input capacitor are positioned on the PCB as close as possible to CON1. This also helps to ensure good linearity up to 200MHz.

By the way, although the peaks at 500MHz and 750MHz look quite dramatic, they don't mean that the Active RF Detector Probe can only be used to make measurements below 200MHz. On the contrary, Fig.3 can be used as a correction curve when making measurements up to 1GHz (1000MHz).

One last point about Fig.3. You might wonder about the significance of the dashed red line extending the plot from 1GHz to 2.45GHz. It's simply my "best guess" of the probe's response above 1GHz, based on some measurements I was able to make at 2.414GHz,

Parts List

1 ABS instrument case, 120 x 60 x 30mm (eg, Jaycar HB-6032)
1 double-sided PCB, code 04107131, 61 x 29mm
2 PCB-mount subminiature DPDT slide switches (Jaycar SS-0823)
2 M3 x 20mm machine screws
2 M3 x 6mm machine screws
2 M3 x 9mm untapped spacers
2 M3 x 10mm untapped Nylon spacers (5mm OD)
4 M3 hex nuts
2 M3 flat washers
2 M3 lockwashers
2 40 x 8mm strips of 0.25mm sheet brass
1 panel-mount BNC socket (CON1)
2 crimp-type BNC line plugs, RG6 cable type
1 plastic cable gland (3-6mm cable size)
2 banana plugs, 1 red, 1 black (Jaycar PP-0394 & PP-0395)
1 9V battery snap
1 9V alkaline battery
1 black alligator clip lead
1 1.5m length of light-duty 2-core red/black cable
1 30mm length of 1mm-diameter hard brass wire
1 100mm length of 1mm-diameter enamelled copper wire
1 35mm length 6mm-dia heatshrink tubing

Semiconductors

1 LMC6482AIN dual CMOS op amp (IC1)
2 1PS70SB82 UHF Schottky diodes (D1,D2)
1 1N4004 silicon diode (D3)

Capacitors

2 10nF 1206 SMD ceramic
1 1μF MMC ceramic

Resistors (0.25W, 1%)

1 1MΩ
2 82kΩ
1 470kΩ
1 20kΩ
1 360kΩ
1 15kΩ
1 160kΩ
1 1kΩ 0805 SMD
1 100Ω

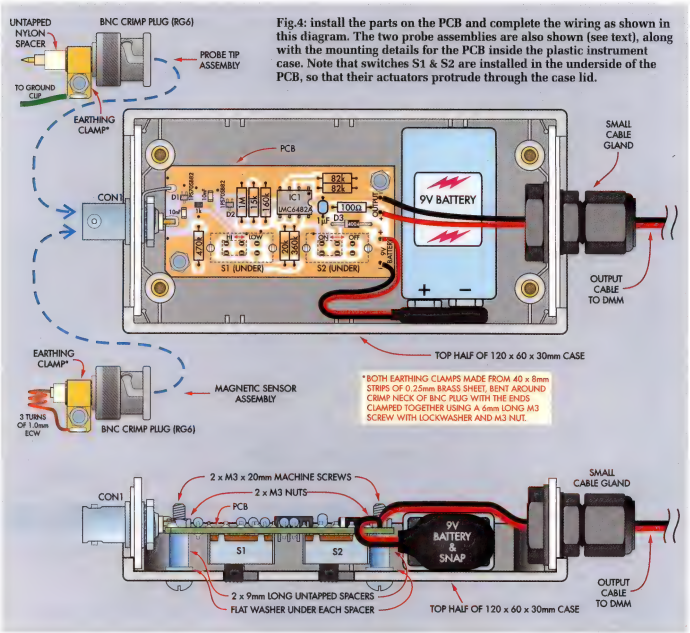


Fig.4: install the parts on the PCB and complete the wiring as shown in this diagram. The two probe assemblies are also shown (see text), along with the mounting details for the PCB inside the plastic instrument case. Note that switches S1 & S2 are installed in the underside of the PCB, so that their actuators protrude through the case lid.

2.432GHz and 2.450GHz using a small UHF generator module. My main RF signal generator only functions up to 1000MHz, so I couldn't make any measurements between 1.00GHz and 2.414GHz. That's why the response line is dashed over this section.

Construction

Almost all the parts are mounted on a small double-sided PCB coded 04107131 and measuring 61 x 29mm. This assembly is housed in a compact ABS instrument case measuring 120 x 60 x 30mm.

The only parts not mounted on the PCB are RF input connector CON1 (which is fitted to an end panel), the cable gland used to anchor the DC output cable (mounted on the other end panel) and the 9V battery which is mounted inside the case behind the PCB.

Virtually all the parts on the PCB are mounted on the top, the exceptions being slide switches S1 and S2. These are mounted on the underside of the board, so that their actuators can later protrude through matching slots in the case lid (see photo).

Follow Fig.4 to install the parts on the PCB. It's a good idea to fit the five SMD parts first. These parts are all mounted in the upper lefthand area of the PCB, very close to the connections for input socket CON1. The only polarised SMD parts are D1 & D2 which should both be fitted with their "two-lead" sides towards the top of the PCB.

Once the SMDs have been installed, the remaining parts can be added. These include the through-hole resistors, the 1µF MMC capacitor, diode D3, IC1 and finally the two slide switches on the underside. That done, solder the battery snap lead in place.

The next step is to solder a 1.5m length of light-duty red/black figure-8 cable to the PCB output terminals. Make sure that the red wire goes to the OUTPUT+ PCB pad and the black lead to the OUTPUT- pad. Once that's done, the PCB assembly is complete and ready for mounting in the case.

Preparing the case

The next step is to drill and cut the

The PCB and the battery are mounted in the top half of the case, which then becomes the lid. Although not shown here, we suggest that the battery snap leads be cable tied the output cable, to prevent them breaking away at the PCB pads.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	1	360kΩ	orange blue yellow brown	orange blue black orange brown
❑	1	160kΩ	brown blue yellow brown	brown blue black orange brown
❑	2	82kΩ	grey red orange brown	grey red black red brown
❑	1	20kΩ	red black orange brown	red black black red brown
❑	1	15kΩ	brown green orange brown	brown green black red brown
❑	1	100Ω	brown black brown brown	brown black black black brown

various holes required in the top half of the case and the two end panels. The locations and sizes for all of these holes are shown in Fig.5. The four circular holes can be drilled and/or reamed to size and in each case, it's best to start with a small pilot drill.

The two rectangular holes are for S1 and S2. They can be made by first drilling a series of small holes around the inside perimeter, then knocking out the centre piece and carefully filing them to shape using jeweller's needle files.

Once all the holes have been made, download the front-panel artwork (in PDF format) from the SILICON CHIP website, print it out and laminate it. Alternatively, if you don't have access to a hot laminator, print it out onto photo paper. That done, cut out the switch holes and the two screw holes using a hobby knife, trim the label to size and attach it to the upper half of the case using double-sided tape.

The PCB assembly can now be mounted inside the upper half of the case. Fig.4 shows the mounting details. As can be seen, it's supported on two M3 x 9mm untapped spacers plus a flat washer under each spacer, and secured using M3 x 20mm machine screws and M3 nuts.

The flat washer under each spacer is necessary to ensure that the PCB is spaced up from the case by nearly 10mm. This allows the slide switches to just protrude through their matching rectangular holes and, at the same time, ensures that the top of the PCB subsequently just sits under the centre contact spigot of CON1.

CON1 can now be mounted on the lefthand end panel. Make sure that its earthing lug is orientated horizontally in the direction shown on Fig.4 and that the attachment nut is firmly tightened. This panel is then lowered into the lefthand end of the case and CON1's earth lug bent around as shown so that it sits just above the matching earth solder pad on the PCB.

The earth lug and CON1's centre spigot can now be soldered to their respective pads.

Final assembly

Now for the final assembly. First, slip a 35mm-long length of 6mm-diameter heatshrink over the output cable and slide it right down to the PCB (it later runs across the battery). That done, fit the cable gland to the righthand end-panel, then pass the output cable through it and lower this end assembly into place.

The next step is to fit the battery, after which most of the slack can be taken out of the output cable and the cable gland tightened. The battery will now be secured under the output cable, with the heatshrink running across it.

The free-end of the output cable must be fitted with banana plugs, to make the connection to the DMM. Fit a red plug to the red (+) output lead and a black plug to the black (-) lead.

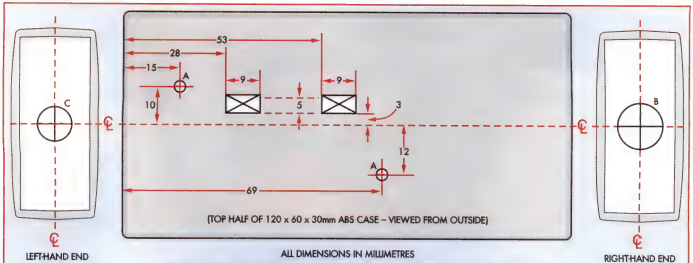


Fig.3: this diagram can either be copied or downloaded from the SILICON CHIP website and used as a template for drilling the two end panels and the top half of the case. The switch cutouts can be made by drilling a series of small holes around the inside perimeter, then knocking out the centre piece and filing to shape.

The Active RF Detector Probe assembly is now complete and you can fit the lower half of the case, fastening it all together using the four countersink-head M3 screws supplied with it.

Making the probe tips

Before using the unit, you first have to make the two interchangeable probe tips – or to be more accurate, a probe tip and a magnetic sensor (or sniffer) probe.

As shown in Fig.4, these are both based on a standard crimp-type BNC line plug (ie, where the centre conductor of a coaxial cable is soldered to the plug's centre pin but the outer shielding braid is connected to a ferrule on the rear of the plug by crimping it inside a thin metal sleeve).

In this case, we're using plugs designed for crimping onto RG6 cable, as these have a ferrule with an inner diameter of about 5mm. They're stocked by Jaycar as Cat. PP-0657.

In this application though, we don't actually crimp the earth connections to the BNC plug ferrules. Instead, the earth connections are soldered to small P-clamps which are then attached to the ferrules using M3 x 6mm machine screws, lockwashers and nuts (see photo).

The P-clamps are bent from 40 x 8mm strips of 0.25mm brass sheet, with 3mm holes drilled in the flat ends to accept the M3 screws. Once made, secure them to the BNC plug ferrules as shown.

Specifications

- An RF Detector Probe designed to allow low-level RF signals to be measured using a standard DMM (set to volts DC). It provides two measurement ranges, with the LOW range incorporating compensation for detector diode non-linearity. The input configuration allows use of a probe tip for electrical coupling, a magnetic sensor for magnetic coupling or a direct coaxial connection for RF power measurements (see text).
- **Input impedance:** approximately 1kΩ.
- **Output resistance:** <1kΩ.
- **Frequency response:** from below 100kHz – 200MHz ±5%, rising to peaks at 500MHz and 750MHz; see Fig.3. This plot can be used to correct readings for measurements above 200MHz.
- **High range linear coverage:** RF signals from 600mV to 10V RMS. Maximum input level 10.6V RMS.
- **Low range linear coverage:** RF signals from 20mV to about 5V RMS. Maximum input level 5.6V RMS (note: maximum DC input level for both High and Low ranges is 50V).
- **Power supply:** internal 9V alkaline battery; battery drain < 2mA.

Probe tip assembly

The probe tip assembly is made using a 30mm length of 1mm-diameter hard brass wire, with a sharp point ground or filed at one end. The other end of this wire is then passed into the rear of the plug's centre pin and secured by soldering the two together (don't leave a large solder "blob" at the joint though). That done, the pin-and-tip assembly is pushed all the way into the plug (from the ferrule end) until the pin "clicks" into position inside the connector.

Once the tip assembly is in place, you then slip an M3 x 10mm untapped Nylon spacer (outer diameter 5mm) into the rear of the ferrule, to act as an insulator/dielectric. A short length of PVC insulation from a 230V mains lead conductor is then slipped inside the Nylon spacer to support the probe tip more securely. Finally, a short earth lead (eg, about 70mm long) fitted with an alligator clip is soldered to the brass P-clamp.

Magnetic sensor probe

The magnetic sensor (sniffer) probe is made in a similar way. However, instead of using a 30mm-length of brass wire for the tip, we instead use a 100mm-length of 1mm-diameter enamelled copper wire, with its centre

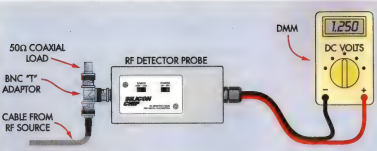


Fig.6: direct RF voltage measurements can be made in coaxial cables by using the configuration shown here. Because the load resistance is known (ie, 50Ω), this also allows you to calculate the RF power (see also Table 2).

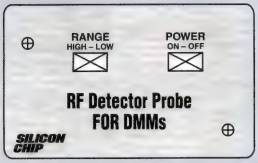


Fig.7: this front-panel artwork can be copied and laminated. The artwork can also be downloaded in PDF format from the SILICON CHIP website.

Table 2: Volts to Power Conversion

VOLTS RMS	POWER (50Ω)	VOLTS RMS	POWER (50Ω)
10.0	2.0 W	446 mV	4.0 mW
8.9	1.6 W	398 mV	3.2 mW
7.9	1.26 W	354 mV	2.5 mW
7.07	1.0 W	316 mV	2.0 mW
6.30	794 mW	282 mV	1.6 mW
5.62	631 mW	251 mV	1.26 mW
5.01	501 mW	224 mV	1.00 mW
4.46	398 mW	199 mV	790 µW
3.98	316 mW	178 mV	630 µW
3.54	251 mW	158 mV	500 µW
3.16	200 mW	141 mV	400 µW
2.82	158 mW	126 mV	320 µW
2.51	126 mW	112 mV	250 µW
2.24	100 mW	100 mV	200 µW
1.99	79 mW	89 mV	160 µW
1.78	63 mW	79 mV	126 µW
1.58	50 mW	71 mV	100 µW
1.41	40 mW	63 mV	80 µW
1.26	32 mW	56 mV	63 µW
1.12	25 mW	50 mV	50 µW
1.00	20 mW	44.6 mV	40 µW
890 mV	19 mW	39.8 mV	32 µW
790 mV	12.6 mW	35.4 mV	25 µW
710 mV	10 mW	31.6 mV	20 µW
630 mV	8.0 mW	28.2 mV	16 µW
560 mV	6.3 mW	25.1 mV	13 µW
501 mV	5.0 mW	22.4 mV	10 µW

section first bent around a 3.5mm rod or mandrel (eg, a 3.5mm drill bit) to form three neat turns.

Both ends of the wire are then bared for about 4mm, after which one end is soldered into the rear of the plug's centre pin. A Nylon spacer and an inner PVC sleeve are then fitted inside the plug's ferrule, after which the pin end of the coil wire is pushed carefully into place until the pin clicks into position inside the BNC connector.

It's then just a matter of carefully bending the sniffer coil's free end into position so that it can be soldered to the previously-installed P-clamp.

This view shows the two completed RF probes, one using a probe tip and the other a coil to act as a "sniffer".

Using the RF probe

There are no adjustments to make before using the probe. It's simply a matter of plugging the output cable into the input jacks of your DMM, setting the DMM to an appropriate DC voltage range (eg, 20.0V, 2.00V or 200mV) and then setting the two switches on the probe.

S2 simply switches the power, while S1's position mainly depends on the likely signal level that's to be measured. If you're not sure of this, it would be a good idea to push S1 into the HIGH position, just to be safe. You can then select the LOW position for a more accurate reading if the signal proves to be lower than about 1V RMS.

Note that if you want to measure RF signal voltages, you'll mainly want to use the probe tip and its ground lead. That's because the magnetic sensor provides an induced voltage due to RF current in the circuit you're testing. So the voltage readings don't mean much, although they do allow you to make comparisons.

Because we have used a BNC coaxial socket as the input for the Active RF Detector Probe, this also allows it to be used for direct RF voltage measurements in coaxial cables. This means that it can be used in conjunction with a 50Ω coaxial load and a look-up table to make low-power RF power measurements, by using the configuration shown in Fig.6.

As you can see, this involves fitting a BNC T-adaptor to the probe's input socket and then fitting a 50Ω coaxial load to one side. The input cable from the low-power RF source you want to measure is then connected to the other socket on the T-adaptor, and Bob's your uncle.

Of course, the Active RF Detector Probe and DMM combination only measures RF voltage; it doesn't measure power directly. However, it's relatively easy to convert the voltage level into power, since you also know the load resistance.

For example, if you're using a 50Ω load as shown in Fig.6, you can use Table 2 to look up the value. Just don't forget to correct the voltage reading using the plots in Figs.2 & 3 – and also multiply the reading by 10, if you're using the Probe's HIGH range – before you convert it to power. SC

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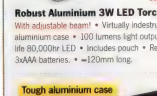

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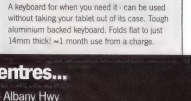

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iPad for illustration purposes only.

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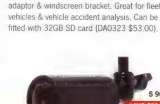

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Designed both as a dashboard camcorder and a Full HD portable handi-cam for documenting your adventures! Fully adjustable 2.5" flip screen and rotating lens. Includes car power adaptor & windscreen bracket. Great for fleet vehicles & vehicle accident analysis. Can be fitted with 32GB SD card (DA0323 $53.00).

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B&W Waterproof CCD Camera
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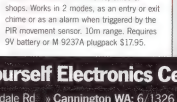

SAVE 25% $22

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K 1143

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(SC Oct '10) Tells you exactly where you are - never get lost at sea again. Also shows speed and heading - plus it will navigate you back home - or to that secret fishing spot! It even displays fuel consumption, along with a host of other vital information.

K 5116

20W Amp Module Kit

(SC Dec '04) Extremely simple amplifier kit designed to be easy enough for beginners to assemble. Delivers 20W RMS, ideal for mini hi-fi or a PC sound system. Power supply kit to suit, K 5117 $14.95.

K 6145

Remote Control Digital Timer Kit

(SC August '10) Switch low voltage devices on/off after set periods. Operated by the included universal remote control.

• Trigger inputs • DPDT relay output (30VDC/24VAC - not suitable for mains switching) • Requires M 9237A 9V plugpack $17.95.

K 5526

Stereo Audio Level Compressor

(SC Jan '12) Do you hate the way the sound level on your TV suddenly jumps during the advert breaks or between channels? This compressor fixes those problems by reducing the dynamic range of the signal while still maintaining clean sound. Also ideal for use with PA systems. Requires 12-30V DC power (12V plugpack to suit M 9272B $17.95).

K 2510

LED Strobe & Tachometer Kit

(SC August '08) Allows you to measure the RPM of fans, shafts, propellers or anything that rotates - up to 65,000 RPM! Readout displays RPM and frequency. 1 RPM resolution. Adjustable flash period & divider options. Requires 12VDC power.

K 6044

Champion Pre-Amp Kit

(SC Jan '13) Designed to complement the K 6066 Champion Amp kit. It utilises a low voltage op-amp IC with considerably better performance than earlier designs. Provides added gain when used with mics & instruments. Requires 4-13.5V DC.

K 2553

Digital Audio Signal Generator Kit

(SC March '10) With S/PDIF coaxial and optical output - plus dual analog outputs! Incredibly low distortion (typically <0.06%). Sine, square, triangle and sawtooth wave generator. Plus waveform mixing, pulse and sweep modes. Ideal for RMS and music power testing of amps or speakers; testing DACs & crossovers. Requires 4xAA or 9V plugpack.

Great for D-I-Y & trades.

K 6043

Take the 'kick' out of your power tools!

(SC July '12) This handy soft starter kit prevents your electric saw, router or other large mains-powered hand tool from kicking when you squeeze the trigger. Ensures a clean accurate cut every time. Max load 10A.

Fully updated Musicolour for LED lights

K 5804

LED Musicolour Kit

(SC Oct '12) Updated Musicolour for LED! A continuously changing kaleidoscope of colour changing in time to the music. Controls up to 16 strings of LEDs tuned to frequency bands. Great for Christmas lighting and parties. 12-24VDC input (current dependant on connected load)

K 6066

Champion 7W Amp Kit

(SC Jan '13) A fully upgraded version of the old 'Champ Amp'. Delivers up to 7W of peak power with low distortion. It also offers muting and standby control, plus two mixed inputs. All on a tiny board! 4-13.5V dc input.

K 6009

K 6011 light beam trigger kit to suit $29.95

Take amazing stop motion photos with your camera!

(SC Jan '09) Flash Camera Trigger Kit. Take pictures at precise moments from 1ms to 9.99s after a trigger. Triggering can be via included electret mic or other sensors like a PIR detector, light-beam interrupter, or sensor switches (not included). Requires 9V battery (S 4931 $7.25).

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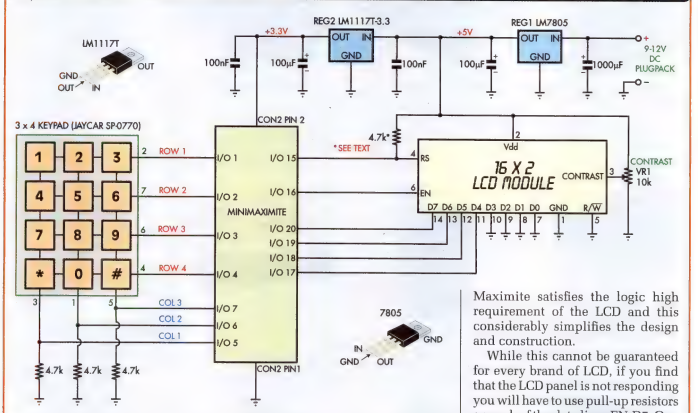
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions will be paid for at standard rates. All submissions should include full name, address & phone number.



Keypad & LCD for MiniMaximite

The MiniMaximite (SILICON CHIP, November 2011) was designed to be used as an embedded controller but if you take it away from its USB umbilical cord attached to your computer, how do you feed in numerical data? In a previous contribution it was shown how to input data using a Sony remote control and this article shows how to get numerical input from a 4 x 3 keypad (eg, Jaycar SP-0770) and display the number on a 16x2 LCD.

The above circuit diagram shows the structure of the keypad as a 4-row x 3-column matrix of conductors. If a keypad number such as "8" is pressed, this causes a connection to be made between the row and column passing under the "8" button. For the number "8", there will be a connection between row 3 and column 2. If output I/O 3 is taken high, this connection will cause input I/O 6 to change from low to high.

To detect which button was pressed the software sets each row high in turn and then examines if any of the columns is high. If such a high is detected the key which was pressed can be identified.

To enter a number, simply press each digit in turn, starting with the most significant digit. Your entries will be echoed on the LCD. When the entry of digits is completed, press the "#" key and the completed number will be available as a string in the variable "num$" or as a number in the variable "num". The number is also displayed on the LCD.

If you make a mistake during digit entry, the "*" key will act as a backspace key.

The connections between the MiniMaximite and the LCD are fairly straightforward; just watch the pin numbering on the LCD. Some have the ground and Vdd lines reversed.

One thing that does require commenting on is the fact that the MiniMaximite is being used to directly drive the LCD. The MiniMaximite has a 3.3V supply so its outputs are limited to 3.3V.

The LCD on the other hand, operates on a 5V supply and expects logic highs appropriately. However, the available output from the MiniMaximite satisfies the logic high requirement of the LCD and this considerably simplifies the design and construction.

While this cannot be guaranteed for every brand of LCD, if you find that the LCD panel is not responding you will have to use pull-up resistors on each of the data lines EN-D7. One such pull-up resistor is shown.

You will also have to re-define the outputs I/O 15 to I/O 20 as "open collector" in the program. To do this, the line:

for i = 15 to 20:setpin i,8:next i

will need to be changed to:

for i = 15 to 20:setpin i,9:next i

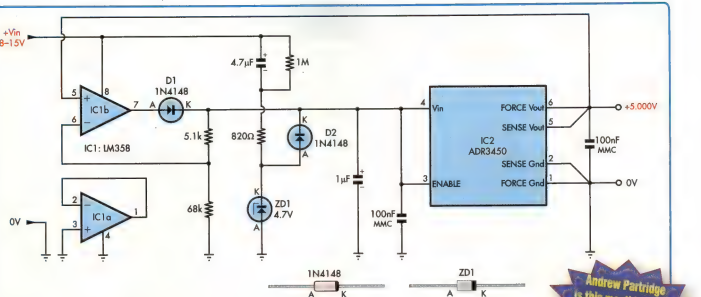
For outputting data to the LCD, you will find two subroutines in the program. The first is the subroutine *PrintLCD (lin, place, text$)*. The arguments are:

- lin = the line number on which to print the text (lin will be either 1 or 2)
- place = the position on the line to start displaying text (place will range from 0 to 15)
- text$ = the text (up to 16 characters) to print

So the subroutine call *PrintLCD (1,0,"SILICON CHIP")* will cause the LCD to display the text **SILICON CHIP** on the first row at the beginning of the line.The other subroutine is *ClearLCD* which simply clears the whole display.

The software, *ketpadsc.bas*, is on the SILICON CHIP website.

Jack Holliday,
Nathan, Qld. ($65)



Andrew Partridge is this month's winner of a $150 gift voucher from Hare & Forbes

Pre-regulator for a precision voltage reference

The ADR3450 is an inexpensive 5V voltage reference with ±0.1% accuracy. However, the input voltage range is quite narrow. For a load current of 2mA the input range is 5.25V to 5.50V. This makes it essential to pre-regulate the input voltage.

My initial plan was to use an LM317L as the pre-regulator but even with precision resistors to set the output voltage to 5.375V (the middle of the 5.25V to 5.50V acceptable range), the tolerance of its reference voltage is not tight enough to guarantee that the output voltage would fall into the acceptable range.

Rather than use an expensive close-tolerance voltage reference as the pre-regulator, this circuit was designed to use the output of the ADR3450 itself as a reference to set its own input voltage. One op amp from an LM358 package is connected as a non-inverting amplifier with a gain of 1.075. This transforms the 5.000V output of the ADR3450 to become the required 5.375V input. The maximum supply voltage of the op amp now determines the maximum input voltage accepted by the circuit.

At power-up, the circuit relies on positive feedback between the ADR3450 and the non-inverting amplifier to take the ADR3450's Vin pin from an initial low start-up voltage to the full 5.375V.

This positive feedback only happens when the gain of the non-inverting amplifier more than makes up for the voltage drop across the ADR3450. For a drop-out voltage of 250mV and an amplifier gain of 1.075, the initial voltage at the input to the ADR3450 has to be at least 3.583V for positive feedback to occur.

The start-up voltage is generated by the 4.7V zener diode (ZD1) and its 820Ω current limiting resistor, and is applied to the pin 4 input via diode D2. This arrangement limits the start-up voltage to 4.1V.

The 4.7µF capacitor in series with the 820Ω resistor is a power saving measure. It allows current to flow into the start-up circuitry at power-up to provide the initial start-up voltage. As the capacitor charges following power-up, the current into the start-up circuitry drops to zero. The 1MΩ resistor discharges the 4.7µF capacitor when power is removed, ready for the next power-up cycle.

The specified value of 4.7µF guarantees successful start-up with a supply voltage of 8V and with a load on the output of the ADR3450 drawing 2mA and having 1µF capacitance. Increase the value of the 4.7µF capacitor if the load current or capacitance will be higher or if the supply voltage only ramps up slowly at power-up.

Even if further capacitance (up to 10µF) is connected to the output of the ADR3450, do not omit the 100nF ceramic capacitor at the output as it is required for proper operation.

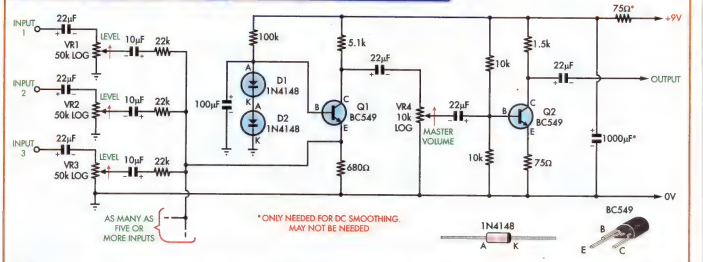
To enable the output of the ADR3450, its ENABLE pin 3 must be taken above the higher of 0.7V and (0.85 x Vin). This is achieved by connecting the ENABLE pin of the ADR3450 to Vin (pin 4).

Diode D1 protects the output of the op amp from the start-up voltage. It is placed inside the non-inverting amplifier's feedback loop to ensure it doesn't affect the accuracy of the amplifier's output voltage.

The location of D1 inside the amplifier's feedback loop does mean that a portion of the start-up voltage is applied to the inverting input of the op amp via the gain-setting potential divider. However, this does not cause the circuit to malfunction because the positive feedback condition also guarantees that at start-up the voltage at the non-inverting input of the op amp will be higher than the voltage at its inverting input. The output of the op amp will therefore start to swing high at power up. As soon as the voltage at the cathode of D1 exceeds the start-up voltage, D2 is reverse biased. This disconnects the start-up voltage and allows the amplifier to operate normally.

Positive feedback between the ADR3450 and the amplifier then increases the voltage at the Vin pin of the ADR3450 until its output stabilises at 5.000V, at which point Vin stabilises at 5.375V.

Andrew Partridge,
Toowoomba East, Qld.



Extendable circuit uses grounded base mixer stage

This novel mixer circuit can be easily expanded for any number of inputs. It relies on the fact that the mixer stage transistor Q1 is connected in a common base configuration, which means that the emitter represents a virtual earth point. This allows you to connect many inputs to the emitter in parallel and they will have negligible influence on each other.

While the grounded base transistor may look unconventional it operates in virtually the same way as a common-emitter stage, with the input signal still being applied between base and emitter. The difference is that the base is grounded instead of the emitter. The gain provided by Q1 is roughly equal to the ratio of the collector and emitter load resistors and in this case will be about seven times.

The circuit only shows three inputs but you could connect many more, although ultimately noise will be a limiting factor. VR1-VR3 allow the inputs levels to be matched.

The output of Q1 is fed to the master gain control VR4 and then to a common emitter gain stage employing NPN transistor Q2.

Only one channel is shown. You will need to duplicate this for the second channel, if you want a stereo mixer.

Christopher Ross,
Tuebingen, Germany. ($50)

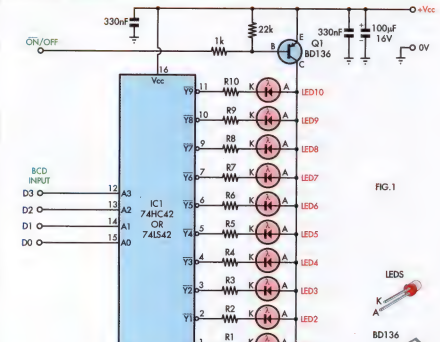


FIG.1

Bar & dot display drivers with BCD decoders

Column LED displays typically have two working modes: dot and bar. BCD (binary coded decimal) decoders as the 74HC/LS42, 74HC/LS138, 74HC/LS139, 74HC538 and similar can be used to build low-cost display drivers working in bar or dot modes.

These circuits are built around the low-cost 74HC/HCT/LS42 decoders but can be implemented easily around other digital decoders from the TTL or CMOS series and expanded to any appropriate number of LEDs.

The circuit of Fig.1 drives the column of LEDs in dot mode. For example, if we apply the code 0000 on the A0-A3 inputs of IC1 we will light LED1. Similarly, code 0001 will light LED2 and so on.

Consequently, the circuit will work as a conventional dot display driver.

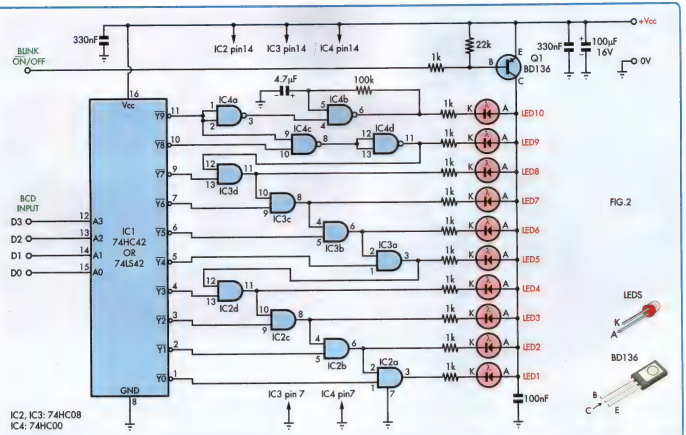


FIG.2

However, it is also possible to light two or more LEDs.

For example, if codes 0000 and 0001 are alternately applied with a frequency higher than about 50Hz, LED1 & LED2 will appear to be lit simultaneously.

In addition, we can use the ON/OFF signal fed to the base of Q1 to switch the LEDs on and off or to modulate the emitted light. That feature can be used to send signals which are invisible to humans but still can be captured from light sensitive electronic devices positioned a short distance from the LEDs.

Fig.2 is configured to work as a display driver in bar mode and it combines the BCD decoder with 2-input NAND gates to ensure that successive LEDs are all driven as the value of the BCD code increases. For example, if we apply the code 0000 on inputs A0-A3 of IC1, we will light LED1. Code 0001 will light LED1 & LED2 etc.

The code 1001 will activate all 10 LEDs (LED1-LED10). However, in that case LED1-LED9 will be lit constantly while LED10 will blink due to the 100kΩ resistor and 4.7µF capacitor connected to pin 5 of IC4b. In this case, the display is mainly operating as a bar display with dot mode for the top digit.

To disable the blinking of LED10, IC4b can be connected as a simple inverter by omitting the resistor and capacitor and connecting pins 4 & 5 together.

Again, Q1 can be driven to switch the LEDs on and off or to modulate them.

Petre Petrov,
Sofia, Bulgaria. ($65)

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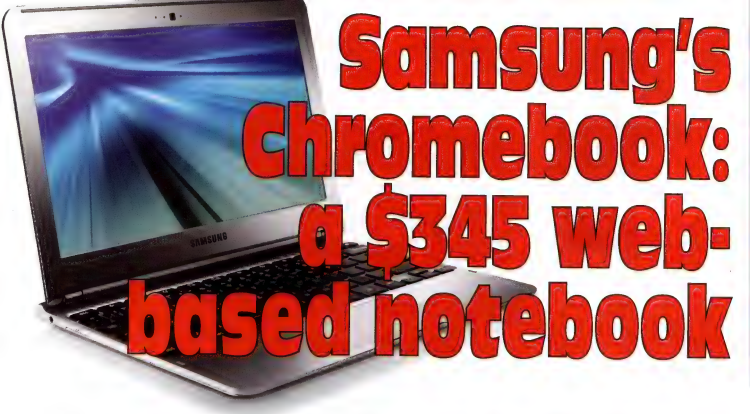


Samsung's Chromebook: a $345 web-based notebook

With the price of notebook and tablet computers continuing to fall, we thought it worth a look at one of the cheapest notebooks on the market – the Samsung Chromebook. Can a computer that retails for less than $350 really be much more than a toy? Ross Tester had a bit longer to play with one than first envisaged . . .

Just a few hours after obtaining a Samsung Chromebook for review, I was forced to spend a totally unplanned week in hospital. No, the Samsung didn't cause it – but that "break"(!) gave me the opportunity to have a really good look at this intriguing machine – and also highlighted its very best and very worst features.

First, the best:

The Samsung Chromebook is small, low cost and very light. It features a nice clear 293mm or 11.6-inch (diagonal) screen and quite a reasonable tactile-key keyboard with standard key spacing and layout (q-p spacing ~185mm) along with a sensitive trackpad.

We mentioned small and light: it weighs in at just over 1.1kg and overall (closed) it's just 17mm thick.

One of its greatest claims to fame is that it boots in just a few seconds – even from power-on it's only about ten seconds and restoring from "sleep", is much less than that. Turning off is even quicker – no waiting around here!

And a feature that doesn't normally rate much of a mention, is that (so far) the Chromebook is virus free – not only due to the machine's inbuilt security but because the malcontents of this world haven't thought it worth their while to start demonstrating their own inadequacies on it.

At a glance . . .

- 295mm (11.6in) display (1366x768)
- Overall size 289.6 x 208.5 x 16.8mm
- 17mm thin when closed
- 1.1kg weight
- Over 6.5 hours of battery life
- Samsung Exynos 5250 1.7MHz dual-core processor with 1MB L2 cache)
- 2GB DDR3L 800MHz system memory
- 16GB solid state drive
- 100GB Google Drive cloud storage*
- Built-in dual-band Wi-Fi (802.11a/b/g/n)
- VGA camera & internal microphone
- 1x USB 3.0, 1x USB 2.0 ports
- HDMI port
- Bluetooth 3.0™ compatible

*free for two years

Now the worst:

Hospitals are not known for their computer-friendliness, at least as far as patients go. While the Samsung certainly found WiFi (and lots of it), all were encrypted so none was available for patient use (I asked!).

And without internet access, the Samsung Chromebook is, for all practical purposes, a 1.1kg paperweight. Now that is by design, because the Chromebook is specifically intended as a "cloud-based" computer.

Perhaps a word of explanation is in order: the computer you are probably used to stores most of its data internally, normally on a large hard disk drive.

Cloud-based computers, on the other hand, don't have this "luxury" – they rely on an internet connection to store data "in the cloud". That's just a buzzword for saying "somewhere else" – probably on a giant bank of terabyte

hard disk drives, equally probably not even in your country. By and large, you don't even know it's happening.

But the operative words here are "rely on an internet connection."

Sure, I could have tethered my mobile phone to the computer and gained net access that way but it was much more convenient to use the Samsung Note 3G tablet that my partner had most thoughtfully given me for my "holiday"!

But back to the Chromebook. With only (relatively) limited internal storage (it doesn't even have a hard disk drive as such but instead sports a 16GB solid-state-drive) it is quite limited on what you can do without resorting to that internet connection.

From its look and feel, it's fairly obvious that the Chromebook is aimed at the internet-user and the entertainment market, although there are more and more "serious" Chrome applications emerging for it.

Incidentally, every Chromebook comes with 100GB of cloud-based storage (called Google Drive) which you can use for two years free of charge. After that, or if you're a data hog, it will cost you.

We're not sure how much that will be because the sales rep we talked to couldn't even get an answer from Samsung. But typical public cloud storage costs between $10 and $25 per gigabyte per month so we'd use these rates as a yardstick.

Who is it intended for?

A replacement for your desktop (or even notebook) computer it is not – and despite some of the marketing hype, we believe was never intended to be. It really is a second (or third) computer.

But there is already quite a large range of productivity apps available; eg, you can easily do the "big four" office-type tasks – writing/editing, database, spreadsheet and some DTP; even limited graphics and photo applications – and many more besides.

And, of course, it is absolutely perfect for browsing web pages, emailing and other internet-type applications. It *should* be very good for gaming but we have some reservations there, which we'll look at shortly.

But you won't be able to run your familiar "office" applications, such as Microsoft Word, etc, because the Chromebook does not operate under the Windows system, nor even under Android – its operating system is Google Chrome, which (like Android) is based on a Linux platform.

It has a near-standard full-size "QWERTY" keyboard, but the normal "F" keys along the top line are replaced with more internet-specific keys. But where are the caps lock and delete keys? Everyone is used to having them available!

Neither will you be able to run programs such as Skype nor iTunes, for example (but there are many Google Chrome equivalents/alternatives).

However, we would anticipate there will be many more "serious" apps (as distinct from games) in the future.

Incidentally, the "Google Docs" word processing application reads and writes Word-compatible files, so you can use the Chromebook for office tasks and retain some compatibility.

So is Chromebook another Android?

Let's get rid of this common misconception (and often-asked question) early: can you run Android apps on the Chromebook?

The answer is, unfortunately, no. Admittedly, most Chrome apps have the same "look and feel" as Android apps but it's been a common "beef" on the forums and in the press that Google didn't incorporate any Android compatibility.

The reason for this negativity? There are many *thousands* of Google Chrome apps (which you access from the Chrome webstore) but there are *millions* of Android apps which people would like to have. Sorry!

So will this limit the Chromebook market? We believe so.

The hardware

We've already mentioned the light weight – so the Chromebook will be very popular with students (who almost universally these days have school/college/uni WiFi) but can also take notes etc, and perhaps store them internally. The light weight comes from a fairly "plasticy" feeling case.

It's powered by a 1.7GHz Samsung Exynos 5 dual-core CPU which has a 1MB cache. There is 2GB of system memory. We've also mentioned the 16GB SSD which, even after taking out the space required for the operating system, graphics drivers and sundry "unseen" overheads, is argued can store a reasonable amount of material on-board. Just don't try a lot of material or really large files!

So perhaps we were being harsh when we called it a paperweight if it didn't have net access.

Speaking of the net, it will automatically seek any available WiFi connection (802.11a/b/g/n) and give you the usual options for logging on (including password if required).

The integrated graphics powers the 1366 x 768 pixel LED display, and as we mentioned earlier, it's clear and crisp. Viewing angle is passable, if not brilliant and while Google claim it can play 1080p video, it's cannot display full HD.

There's a 0.3MP web camera (ie, it faces the user) but it can't run the most popular personal communication tool, Skype. Battery life is claimed to be about 6.5-7 hours and we more-or-less confirmed this.

The keyboard doesn't have the familiar "F" keys above the numerics; instead it has a dozen "web-enabled" keys, again pointing to the intended

Shown here about 2/3 life size, the rear panel of the Samsung Chromebook sports a blanked-off socket for (as yet unavailable) 3G, a USB3.0 socket, a USB2.0 socket, HDMI output and DC power/charging socket & LED.

use of the computer.

As far as expansion and peripherals goes, there's not much available. On the review model, there was a single SD/SDHC/SDXC card reader, one USB3.0 port and one USB2.0 port, an HDMI display output and a headphone/microphone combo 3.5mm socket.

One thing I did find a bit disconcerting was that a standard SD card pokes out the side by about 5-6mm or so – just enough to snag on something. You really have to remove the SD card when not in use.

There are two tiny bottom-mounted speakers but they certainly aren't what you'd describe as hifi (in fact, not even fi!) – especially when sitting with the computer on your lap. You'd be much better off using external speakers or earphones.

And that's about it.

Of course, any printing you want to do will have to be either via WiFi or via the USB port; then again, most printers these days are USB devices.

It is our understanding that none of the internals can be changed or upgraded – you've got what you've got!

When you turn it on . . .

It's already loaded with several "helpful" Google apps, such as search, Gmail, YouTube and the like, so you can start playing (literally!) immediately.

If you're coming straight out of a Windows/PC background, Google Chrome has a bit of a learning curve; if you're already familiar with Android, you're most of the way there already.

If you don't find the app that you want already installed, it's not difficult at all to log onto the Google Webstore and search for what you require. You'll almost certainly end up spending a lot of time here to see just what is available! But that's typical of Android/Apple/Windows users as well.

In use

What can I say? It did what it was supposed to do, providing it wasn't overtaxed. Opening multiple browser windows (yeah, I know, it's not a Windows machine!) caused it to become a bit sluggish. At times it had trouble keeping up with a video or song – even with a rock-solid WiFi connection linked to a cable modem.

I mentioned reservations about gaming earlier on – it is for this apparent sluggishness that I have these thoughts. But I must admit, I am not a "serious" gamer and therefore did not try it out on any games which might give it (or me!) a headache!

However, for its intended use – a net-based browser and light-weight productivity machine – it was more than adequate, for most of the time I used it.

Free updates – automatically

Apart from dowloading apps, the maintenance and chores of a typical Windows or even Apple computer are gone – Samsung has an update (apparently every six weeks) that happens when you next turn the machine on. And they're not like Microsoft's infamous Tuesday updates – come back when you've made a cup of coffee or built the Pyramids, whichever is the sooner. You aren't even aware that updates are happening.

Let's cut to the chase!

So would I recommend the Samsung Chromebook? Yes I would, in fact very much so – as long as you kept in mind that it is NOT a replacement for your "normal" computer. (Especially) used as a web browser (and especially given its lightning boot-up), with some "productivity" tasks thrown in, it really comes into its own. For the price, it's a bargain!

Nearly forgot: there's some subtle but really annoying differences between the Chromebook's keyboard and the one you've been used to. Like no caps lock! (Perhaps there's a way to achieve that but I didn't quite get to it). And no delete key.

Splitting hairs? Maybe. But it makes the difference between a glowing report and a nearly-glowing report.

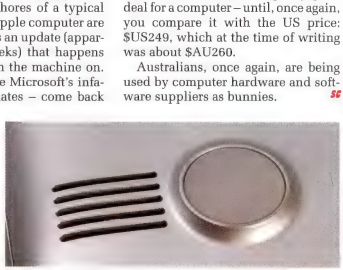
The price

We've said it all before . . .

RRP of the Samsung Chromebook in Australia is $345.00, available from a limited number of retailers (eg, Harvey Norman and JB Hifi in Sydney). At first glance, that seems like a pretty good deal for a computer – until, once again, you compare it with the US price: $US249, which at the time of writing was about $AU260.

Australians, once again, are being used by computer hardware and software suppliers as bunnies. SC

The only other connectors are on the left side: a combo earphone/microphone socket and an SD-card slot. It worries us a little that the card protrudes so far out, though.



Underneath you'll find the two stereo "speakers". They're supposedly rated at 1.5W each . . . but hifi they most definitely aren't. Headphones or speakers sound good!

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K338 3W LED DISK WITH 10-24VDC DRIVER
This kit is almost fully built, only 4 wires to solder. The disk will require a small heatsink. Input: 10-24VDC. Disk: 32mm, Driver: 15 X 15 X 12mm **[K338] $5.00**

K337 5W LED DISK WITH 8- 16VDC DRIVER
This kit is almost fully built, only 4 wires to solder. The disk will require a small heatsink. Input : 8-16VDC. Disc: 50mm, Driver: 22 X 17 X 10mm. **[K337] $7.00**

K339 10W LED WITH 10-24VDC DRIVER
This kit is almost fully built, only 4 wires to solder. The disk will require a small heatsink. Input: 8-16VDC, LED:21 X 21 X 3.5mm, Driver: 26 X 17 X 12mm. **[K339] $12.00**

20W LED + DRIVER + 60MM FAN
Pure White with an output of 1800-2000 Lumens! Comes with a 12V driver & a small fan. Will need to be mounted on a small plate or heatsink. **[20WP] $20.00**

50W LED
Pure White, 32VDC. Will need to be mounted on a small plate or heatsink. **[50W] $20.00**

100W LED
100W Pure White, 32VDC. The LED should be mounted on a plate or heatsink. **[100W] $30.00**

K2524 24V / 24W WATERPROOF SUPER-BRIGHT WHITE LED STRIP
1 X 2500mm LED strip with 6 X 3 chip LEDs every 100mm. 1 X Power adaptor, Input 100VAC - 240VAC, Output 24VDC @ 1A. 1 X Mains lead (as drawn without mains plug). **[K2524] $19.00**

K340 WATERPROOF LED LAMP 10-24VDC
Very bright for a 7W LED, the driver is inside the lamp. Ideal for use out-doors, on vehicles & boats. Machined aluminum body, silicon seals all-round. 75 X 75 + bracket. **[K340] $25.00**

K336 10W MINI LED FLOODLIGHT
Includes suitable mains power adapter. These floodlights are powder-coated, cast aluminum and are waterproof. Ideal for used as reversing lights or work lights on cars, trucks and boats, not subject to damage from vibration DC: 10-25V, AC: 8-18V, DIM: (W)115mm X (H)85mm X (D)85mm, 0.450kg **[K336] $24.00**

K329 20W FLOODLIGHT. NOW FULLY BUILT!
20W Pure White Floodlight with an output of 1800-2000 Lumens! Dimentions: (W)180mm X (H)140mm X (D)100mm (Overall), 1kg, 12V @ 1.9A-(22.8W), 24V @ 0.88A-(21.12W), 6-36VDC. Includes a 24V@1A 100-240VAC power adapter. **[K329] $34.00**

3 and 5W LED LAMPS
This mains operated (ES27) Pure White 5W LED Lamp does not have approvals, but it is supplied with a replacement 12V Driver PCB, Unscrew the lamp, remove and replace the 240V driver PCB. 10-24V DC or 9-17V AC
[ES275] 5W. $12 or 5 for $50
Also available in a smaller, cuter 3W lamp
[ES273] 3W. $9 or 5 for $40

3W LED LAMP
This mains operated Pure White 3W LED down-light does not have approvals, but it is supplied with a replacement 12V Driver PCB, remove & replace the 240V driver PCB. 10-24V DC or 9-17V AC operation. **[DL27] 3W. $9 or 5 for $40**

10W LED FLOOD LIGHT KIT PACKAGE
As reviewed in Silicon Chip Magazine.
2 lamps in series with a PSU. 2 X LED floodlight kits + 1 X 24V power supply **[K318P] $50**

SPECIALS

SOLAR SKYLIGHT KIT [K328] Special introductory price $109.00 1200 X 600 PANEL

Don't let the price fool you, these is a high quality solar panels and LEDs. Inc. one "First Solar" brand FS-272 72W/66V/12KG Panel + 4 20W-34V-0.7A LED's. The LEDs are connected in series/parallel & will require some heatsinking, they give a total of OVER 5000 LUMENS! This system is self regulating, simply connect the panel to the LEDs. The Cadmium Telluride (CdTe) cells are sandwiched between 2 sheets of glass with rounded, polished edges, they are totally sealed and waterproof & have better per-formance at higher temperatures & in lower light.

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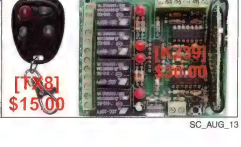
The above 72W Solar Panel is also available with a 12V Regulator/Charger kit. The overall efficiency in transferring power from the panel to the batteries is around 90%. The kit includes a 72W Solar panel plus the Charger kit. If the postage cost is of concern send your address and contact details and / or an order by email to: branko@oatleyelectronics.com
Available mid September. [K330P] $119.

SKYLIGHT DIMMER KIT

This kit is designed to be used with our Solar Skylight Kit, it's dimming ratio is 10:1 This kit comes with PCB and all onboard parts, pot and knob.

PRE-BUILT CODE HOPPING 4 CHANNEL REMOTE CONTROL

This kit is pre-built (2 wires to be soldered). Has individual limit/reset input for each channel. Combined with our TX8 Transmitter (not incl.), this kit can control any combination of four output relays in either moment-ary or latching operation. Features inc. range of ~50m, indicator LEDs, & screw terminals for ease of use.



PRODUCT SHOWCASE

Huawei launch world's slimmest smartphone: 6.18mm thick, with 2 cameras and 1080p HD!

Huawei, one of the world's largest producers of telecommunications devices, have released a smart phone that weighs just 120g and is just over 6mm thick.

The Huawei Ascend P6 is said to have an industry-leading design, a high quality camera and an intuitive user interface.

It's based on the Android 4.2.2 operating system and sports a 4.7-inch HD LCD screen and a 2000mAh battery.

It actually has two cameras, a 5MP front facing model with auto facial-enhancing capabilities and an 8MP *f*/2.0 rear facing model with 4cm macro view, enabling 1080p full HD recording and playback.

With Huawei's proprietary IMAGESmart software, the HUAWEI Ascend P6 turns even the most novice photographer into a professional, with contrast and color enhancement, auto scene recognition, object tracing focus, and instant facial beauty support.

It is already shipping to China and western Europe suppliers, with other markets (including Australia, it is hoped!) to follow very soon.

http://consumer.huawei.com/en/

First "topless" waterproof iPhone5 case with exposed touch screen

An Australian brand, Dog&Bone, has released a rugged Wetsuit iPhone 5 case, which is the first waterproof mobile phone case to leave the phone touch screen uncovered for direct touch. Developers say this is a major advantage when it comes to touch screen sensitivity.

With its patent-pending technology, the Wetsuit iPhone5 case is waterproofed to 2m for half an hour, with dual sealing beads running the full perimeter of the phone, avoiding the need for additional plastic membranes over the screen.

As well as waterproof, it's also dirtproof, snowproof, shockproof, exceeds military standards to withstand drops to 2m, and enjoys an IP68 rating – the highest level of ingress protection from water and dust. The Dog&Bone iPhone5 case is now available for online purchase. For more information, visit:

www.dogandbonecases.com

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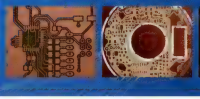

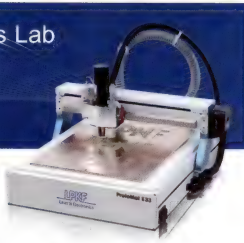

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FishBrain app explodes the myth about morning being the best time to fish!

Lots of SILICON CHIP readers are also keen fishermen. And all good fishermen know you have to get up very early in the morning to catch fish, right?

Well, no!

A clever new app for Android and iPhone called 'FishBrain' has just proved that is the biggest myth in fishing. Statistics from over 40,000 catches shows that it is most effective to fish in the evening!

FishBrain is a mobile social network and the first to gather substantial fishing data through mobile apps. Released in March, it has more than 80,000 members worldwide and gathers data such as lure/bait used, position, species, time, weather, air pressure and much more.

It means that you don't have to rely on memory – and can also use information from other fishermen in your area to give you the best chance to bag that fish! It even gives intelligent recommendations and your friends can follow your adventures in real time.

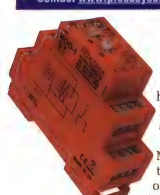
Download the free FishBrain apps from www.fishbrain.com

Plessey's 350mW GaN on silicon LEDs

Plessey has announced that samples of a 350mW LED product (p/n PLB010350) are now available.

These entry-level lighting products are manufactured on Plessey's 6-inch MAGICTM (Manufactured on GaN I/C) line at its Plymouth, England facility. These new LED products are aimed at a variety of solid state lighting and entertainment-type lighting products including accent lighting, wall washing, wall grazing, strip-lighting and a variety of pulse lighting applications.

Contact www.plesseysemi.com



Inline AC current monitor switch

Often in air conditioning and housing for hens, cattle and other livestock it is critical to know fans are working.

In situations such as these the MOD-I from Nortonics can be used to monitor the AC current in a fan or motor and activate an alarm relay when it rises/falls about a set level. The set level is selectable from 0.1 to 10A via a potentiometer. The 16A output relay delays to energise for up to 10 secs when the monitored current rises above the set level as selected by the front timer potentiometer. It will de-energise when the current falls below the set level less a fixed hysteresis of 1% against the set level. De-energisation will also occur if the auxiliary (usually mains) supply is lost. Price is from $64.95 +GST.

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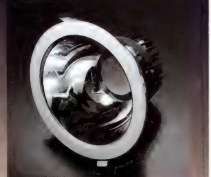

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More 1.5kW Induction Speed Controller Rev

The revised Induction Motor Speed Controller design presented in the December 2012 issue was clearly an improvement over the original circuit and PCB presented in the April & May 2012 issues. It has since been built by quite a few readers and its operation on 3-phase motors is much improved. However, a few readers built the modified design or performed the mods on the original PCB and still managed to blow it up on their particular pump or motor.

We asked the designer, Andrew Levido, to help us come up with some changes to further protect the unit against damage and to fix a few small bugs in operation. The changes he has come up with can be accommodated on the revised PCB presented in the December 2012 issue.

The main problem that constructors have run into appears to be that the overload protection was too slow to prevent damage when running in single-phase mode with heavy loads and high heatsink temperatures. We have taken a two-pronged approach to solving this problem which involves a faster switch-off of the IGBT bridge if the current level rises beyond its normal operating limits and we have incorporated better cooling as well.

To speed up the switch-off under fault conditions, the shunt RC filter components involved with monitoring the load current have been changed to 100Ω and 10nF (originally 2.2kΩ and 1.5nF). This reduces the short circuit trip time from around 3.3µs to 1µs, providing much better protection for the IGBT bridge. This will also result in a faster switch-off under excessive load conditions, which we believe will make the unit more rugged and also lowers the filter impedance to improve noise immunity.

In addition, we have reduced the over-temperature trip threshold from 95° to 85°. This gives a little more headroom to the over-current protection since if the IGBT junctions are already at about 100°, the withstand time at peak current will be reduced.

This change has been done in the software; the thermistor itself is unchanged.

Also, a special condition has been added to the software so that if the heatsink temperature is over 60° when power is applied, the unit will wait for it to cool down first before applying power to the motor.

This is to provide extra protection as the highest currents are normally drawn at start-up, especially when starting under load (eg, with a pool pump) and a hotter heatsink means less margin for the IGBTs under high-current conditions.

Normally this should not be a problem since the heatsink will usually have time to cool between motor runs in this type of situation and besides, we are also improving the cooling which should result in a reduced operating temperature.

Note that we have also changed the value of the 1kΩ resistor feeding zener diode ZD1 to 470Ω. This is not strictly necessary but operates ZD1 closer to its rated power. With the previous value resistor, in a small percentage of cases the reference voltage was lower than expected. It isn't critical but you might as well replace this resistor when you change the other components.

Fan cooling

A number of readers reported a failure of the controller while starting a motor when it was already quite hot. Hence, we decided to add fan cooling.

This has been provided by fitting a small fan (Jaycar YX2505) and grille (Jaycar YX2550) in the bottom of the box and by drilling a row of 6.5mm holes along the top edge of the box to provide airflow. The fan is mounted on the inside of the box and blows the air through and across the heatsink fins.

This has effectively negated the advantage of the sealed IP65 plastic case but we regard the need for cooling as paramount.

The fan is wired to the unregulated input to REG1 (about 6-7V) and so will run quite slowly (and hence, quietly). While it could also be wired across the 15V HOT rail for more efficient cooling, we are not satisfied that the insulation of the fan is adequate.

Adding the fan meant we had to move the output mains connector to the right hand side of the case.

We decided to replace the flush 250VAC socket with a surface-mount type which is more sturdy; the type we used originally is only held in with a single screw and they can come apart if

Motor sions

by Nicholas Vinen

Externally, the differences are the addition of a small fan, necessitating the moving of the mains output socket (which is changed to a more robust type).

you are rough in inserting and removing the 3-pin mains plug.

Hence, we are taking the opportunity to replace it with a better one. If you are using the unit with a three-phase motor then you can use the same connection arrangement as before but you may need to move it across to make room for the fan.

Users may also consider a 240VAC 120mm fan if they will operate for long periods at full load in high ambient temperatures – if nothing else, it will increase the lifetime of the large electrolytic capacitors. However, a large fan will also require a larger case.

A further change to the software has corrected a bug in the 3-phase reversing logic. Now if the reverse switch is changed while the motor is spinning, it will ramp down to zero, change direction and ramp back up again.

Some users also asked for a variation on pool pump mode, where the motor spends less time at full power before dropping to the set speed (half a second rather than 30s). This feature can be useful for lathes or other equipment which start off-load and is activated with Pool Pump enabled and a shorting block across pins 3 & 4 of the ICSP header.

In this case, the ICSP header must be soldered to the PCB, not just held in by friction. We have also expanded the available ramp time range to 1-33 seconds, allowing faster ramp rates than were possible before.

Making the changes

If you are building the Induction Motor Speed Controller from scratch, you can simply fit 100Ω and 10nF RC filter components rather than the previously specified 2.2kΩ and 1.5nF.

If you have already built the unit, you can either remove the PCB from the heatsink and change both of these components or alternatively, clip the 2.2kΩ resistor off (leaving as much lead as possible) and solder a 680Ω resistor across those leads, to give a similar time constant. However, this will not give anywhere near as much noise immunity and may lead to false trips at start-up, so it is better to change both components.

If you do solder this resistor to the top of the board, make sure it's well-anchored as the last thing you want is for this critical component to come loose and possibly cause a short-circuit in the high-voltage section of the unit.

Now is also a good time to change the resistor feeding the zener diode to a value of 470Ω.

Sleeve the fan leads with a continu-

There's also a row of holes drilled across the rear of the case to allow airflow from that fan on the front.

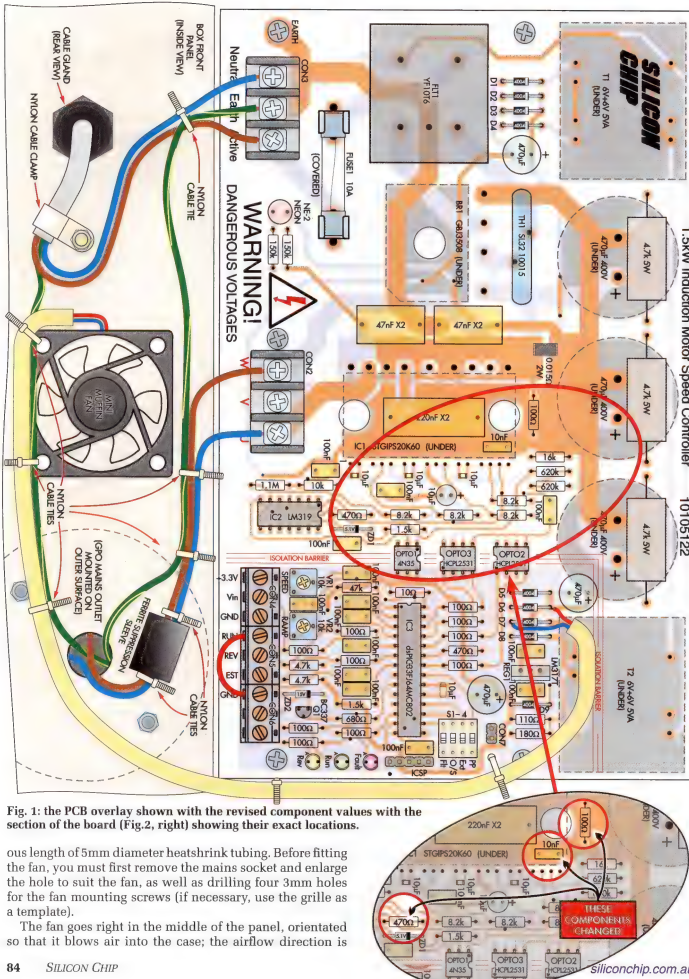


Fig. 1: the PCB overlay shown with the revised component values with the section of the board (Fig.2, right) showing their exact locations.

ous length of 5mm diameter heatshrink tubing. Before fitting the fan, you must first remove the mains socket and enlarge the hole to suit the fan, as well as drilling four 3mm holes for the fan mounting screws (if necessary, use the grille as a template).

The fan goes right in the middle of the panel, orientated so that it blows air into the case; the airflow direction is

This photo shows the component changes along with the revised positioning for the mains outlet to accommodate the new fan. You can also see the row of vent holes drilled along the rear of the case. It is absolutely vital that our layout is followed to the letter – including keeping component lengths short – and that your soldering, especially (but not limited!) to the IGBT, is exemplary. We've found several "faults" which weren't faults at all, due to poor soldering and dress.

indicated with arrows moulded into the plastic housing.

When drilling the holes, make sure the fan (when mounted internally) will sit all the way down against the bottom of the case; this is so that the lid will still fit.

With the fan in place, mark out the three hole positions for the socket to its right. If you use a surface-mount socket like we did, you will need to rotate it about 45°, ie, with screw holes at upper-left and lower right. The screw holes are 4mm while the central hole needs to be large enough to comfortably fit four mains-rated wires through (about 12mm diameter) and should be smooth, ie, no jagged edges.

While you're making holes in the box, drill a row of 6.5mm holes along the top edge, near the heatsink, to allow fresh air to be blown out of the box by the pressure differential generated when the fan is running.

The more holes you drill, the better the airflow will be (to a point) but there's a limit to how many you can put in before the case starts looking like Swiss cheese!

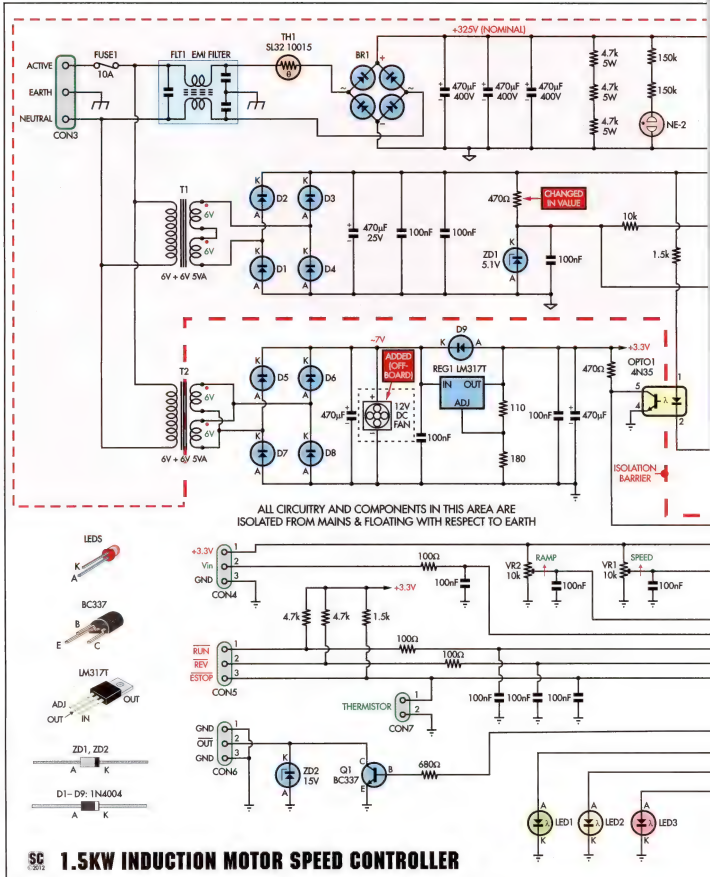
We would recommend drilling at least as many holes as you can see in our photos and try to keep them in a neat row.

Fitting the new parts

Having done that, route the fan power cable around the right-hand side of the board and solder the leads to the cathode of D6 (red) and anode of D7 (blue or black) – see the wiring diagram.

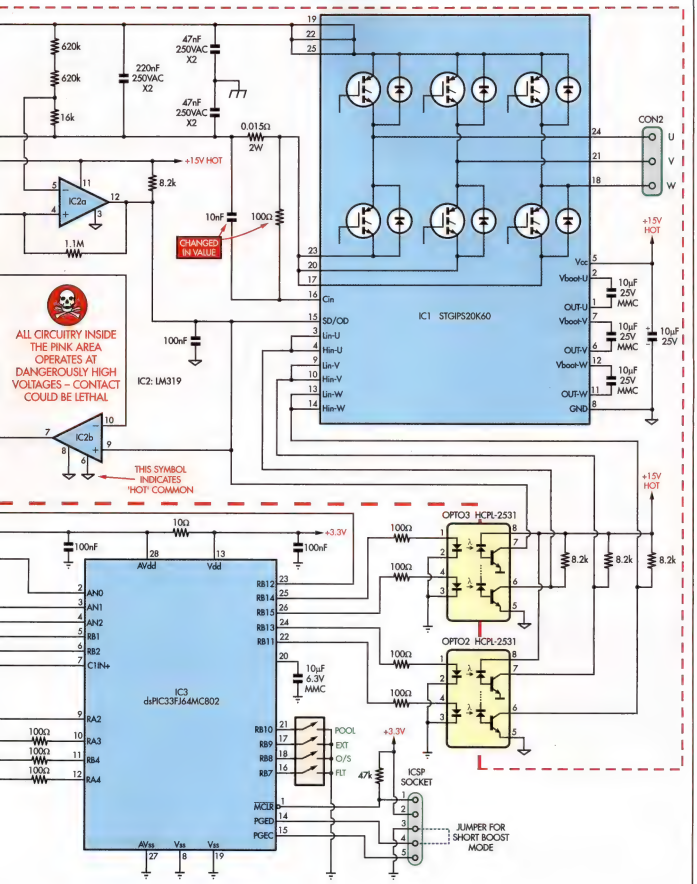
Use the hole for the thermistor wires and the lower-right corner mounting post as cable tie points to clamp the fan cable. This is important as otherwise, the solder joints could break and the wire could easily float around inside the case and cause havoc.

Before mounting the new mains socket, the earth wire of the input lead must be long enough to reach it. To lengthen it, undo the P-clamp holding the input cable in place, disconnect the Active and Neutral leads, loosen the



1.5KW INDUCTION MOTOR SPEED CONTROLLER

Fig.3: for the benefit of those who don't have access to the original article(s), we are reproducing the circuit diagram in full. The three changed components are identified on this circuit, along with the new 12V DC fan. All other changes are in software which, of course, means that the IC3 will need to be re-programmed with a free download from our website.


620k
620k
16k
220nF 250VAC X2
47nF 250VAC X2
47nF 250VAC X2
0.015Ω 2W
+1.5V HOT
8.2k
IC2a
1.1M
10nF
100Ω
CHANGED IN VALUE
ALL CIRCUITRY INSIDE THE PINK AREA OPERATES AT DANGEROUSLY HIGH VOLTAGES – CONTACT COULD BE LETHAL
IC2: LM319
100nF
IC2b
THIS SYMBOL INDICATES 'HOT' COMMON
IC1 STGIPS20K60
SD/OD
Lin-U
Hin-U
Lin-V
Hin-V
Lin-W
Hin-W
Cin
Vcc
Vboot-U
OUT-U
Vboot-V
OUT-V
Vboot-W
OUT-W
GND
10µF 25V MMC
CON2
U
V
W
+1.5V HOT
10Ω
100nF
+3.3V
AVdd
Vdd
IC3 dsPIC33FJ64MC802
AN0
AN1
AN2
RB1
RB2
C1IN+
RA2
RA3
RB4
RA4
RB12
RB14
RB15
RB13
RB11
RB10
RB9
RB8
RB7
MCLR
PGED
PGEC
AVss
Vss
10µF 6.3V MMC
POOL
EXT
O/S
FLT
47k
ICSP SOCKET
JUMPER FOR SHORT BOOST MODE
OPTO3 HCPL-2531
OPTO2 HCPL-2531
100Ω
8.2k

cable gland nut and pull the cable out.

You'll have to guesstimate how much of the insulation to strip off it but perhaps another 150mm will be enough – remember that the earth wire will have to go over the fan and then some way into the back of the mains socket.

Feed the cable back in through the gland but leave it loose. Ignore the extra-long Active and Neutral wires for now and feed the earth wire through the socket access hole. Twist its exposed copper together with the new, longer earth lead for the PCB and screw them tightly into the terminal in the rear of the socket.

Similarly, connect up the new active and neutral wires too and feed them back into the case.

All the socket terminals should be done up extra-tight with a flat-bladed screwdriver to ensure the wires can't come loose.

With the four wires in place, mount the socket using M4 machine screws and nuts, with a shakeproof washer under each head and nut. Make sure they too are done up tight.

You can then cut the new motor connection wires to appropriate lengths and connect them to two of the motor output terminals; don't forget to slip the ferrite suppression sleeve back over them before making this connection and use a cable tie to prevent it from moving around too much.

The earth wire with the loose end is run to the earth point on the input screw terminal barrier at the left side of the PCB and this can be tied to the other wires connecting to the PCB (see photos).

It's then just a matter of re-clamping the mains cable, doing the gland nut up and trimming the incoming active and neutral wires to length before re-connecting them to the respective power input terminals.

Make sure all the wiring is properly tied down so that even if one of the wires breaks or becomes disconnected from the PCB, it can't make contact with something that it shouldn't – if in doubt, refer to the photos of our prototype.

Additional parts required

1 60mm 12V DC fan (Jaycar YX2505)
1 60mm fan grille (Jaycar YX2550)
1 surface-mounting single mains (3-pin) socket
1 100Ω 0.25W resistor
1 470Ω 0.25W resistor
1 10nF MKT metallised polyester capacitor
1 300mm length 6-8mm diameter heatshrink tubing
4 M3 x 20mm machine screws and nuts
4 M3 shakeproof washers
2 M4 x 20mm machine screws and nuts
4 M4 shakeproof washers
1 250mm length mains-rated earth wire (yellow/green striped), 10A+
1 200mm length mains-rated neutral wire (blue)
1 200mm length mains-rated active wire (brown)
10 small cable ties

Updating the software

To take advantage of the improved protection features, bug fixes and extended ramp setting range, you will need to re-program the microcontroller. Make sure the unit is completely unplugged from mains before doing this.

It's simply a matter of connecting the programmer (eg PICkit3) to the 5-pin in-circuit serial programming header, enabling the PICkit's 3.3V power supply for the micro, loading the HEX file and re-flashing the chip.

Alternatively, you can swap the dsPIC33 chip out for another one which has been pre-programmed with the latest version of the firmware (1010512B.HEX).

This will be made available for download from the SILICON CHIP website, free of charge.

Once the chip has been reprogrammed, go over the unit carefully to make sure all the changes have been made properly and nothing is loose, especially the mains wiring. You can then go through the test and set-up procedure from the previous article (May 2012).

Essentially, this involves powering the unit up from mains with no load attached and checking that the neon lights up and the green LED flashes and then after a short period, goes solid.

Assuming it checks out, you can switch off, connect a motor (ideally, unloaded) and power it back up to check that it is operating normally. SC

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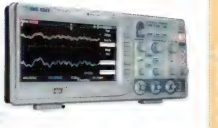

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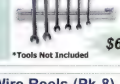
* Width: 410mm
***Manufacturer: DURATOOL**



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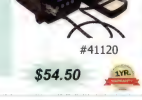

#41120

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1YR. WARRANTY

DRILL BIT SET, HSS, MICRO, 20PC

#40416

* DRILL BIT SET, HSS, MICRO, 20PC
* Kit Contents: 20 Pieces of 0.3,0.35,0.4, 0.45,0.5,0.55,0.6,0.65,0.7,0.8,0.9,0.95, 1.0,1.2,1.3,1.5,1.6mm Drill Bits
* Drill Bit Type: Twist / Jobber
* Material: Titanium Coated
***Manufacturer: DURATOOL**

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* 44 Compartment Cabinet Organiser
* Including Liner draws at the bottom
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* Size(HxWxDmm):510 x 306 x 147
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12V 7Ah AGM VRL Deep Cycle Battery

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* Technolgy:Absorbent Glass Mat
* Alarm Systems, UPS , Power Tools Medical Equipment ,Security Systems
* Weight:2.17kg
* Size(mm): 151(L) x 65(W) x 100(H)mm
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0.9mm Tinned Copper Wire 500g

#41450

Device:TCW18-500g
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Weight: 500g
Reel Length:86m
Wire Size:20SWG
Current:33A
RoHS:Yes

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* Technolgy:Absorbent Glass Mat
* Alarm Systems, UPS , Power Tools Medical Equipment ,Security Systems
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* Size(mm): 181(L) x 77(W) x 167(H)mm
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Vintage Radio

By Associate Professor Graham Parslow

Restoring a 1946 HMV Model 456A mantel radio

Above: the fully-restored HMV Model 456A. The cabinet in particular required a lot of work.

Built into an attractive up-market timber cabinet, the HMV 456A is a mid-price large mantel set from 1946. The circuit uses just four valves and covers the AM broadcast band only.

Francis Barraud's painting of the Jack Russell terrier Nipper, titled "His Master's Voice". The image was acquired by the newly-formed Gramophone Company in 1899 and the design was used on its record labels from 1909. Photo: HMV/EMI Archives.

SOME SETS ARE a real challenge to restore and this 1940s HMV 456A mantel set was no exception. The set in my possession was a gift but it brought with it "obligations" that a bargain purchase would not. The radio was passed onto me by Peter, a fellow member of the Mustang Car Owners' Club, who knew that I collected radios.

Basically, Peter has a mate who was going to throw the radio away but Peter saved it, thinking that it was part of our radio heritage and as such, should go to a caring collector. It was transferred between our car boots on a dark night but in the cold light of day, it looked to be more a liability than an asset – not that I wasn't appreciative to have had it given to me.

Unfortunately, this set had had a hard life. The dial glass was missing and timber cabinet was water damaged. The wood veneer was also cracked and had de-laminated in several places, while the righthand end panel of the cabinet was missing.

If I had paid a few dollars for it, then it would have gone straight onto my spare parts shelf to be cannibalised. However, because it had been given to me and because it's potentially such a nice set, I felt that I had some moral obligation to fully restore it.

Identifying the set

Confirming the identity of this set was easy because the top of the case and the speaker were both branded HMV and the chassis proclaimed the radio to be a model 456. If the dial glass had been present, it would have been even easier.

Searching through the "Australian Official Radio Service Manuals" locked in the year of manufacture as 1946. This was the year that domestic radio production resumed after ceasing in 1941 for the remainder of WW2.

During the war, HMV was occupied with developing and manufacturing radar. However, despite the many advances made during this time, the components and circuits used for ra-

These photos of the cabinet and the chassis shows the very poor condition of the set prior to restoration. The cabinet had been badly water damaged, the righthand end panel was missing and two of the knobs were also missing.

dios manufactured immediately after the war were little changed from the early 1940s designs. Part of the reason for this was that old stock had been stored and it was prudent to use it.

In the HMV model 456, the valve line-up is quite conventional, as is the electrodynamic speaker with its 1500Ω coil that serves as both an electromagnet and a filter choke for the high-tension rail. In fact, the model 456 circuit is almost identical to the 1939 HMV model 449.

The relatively simple 4-valve configuration made the set more attractive for me to restore because my collection already included the more expensive 5-valve 2-band HMV model 886. The 886 is contemporary with the model 456 and used the same style of timber cabinet which is also a pre-war design. Because my model 886 was in pristine condition, I could see what the model 456 should look like once it had been restored.

The famous HMV logo

His Master's Voice is the title of a painting by Francis Barraud which featured the dog Nipper listening to a cylinder phonograph. The trademark image was later acquired from the artist in 1899 by the newly-formed Gramophone Company (London) and subsequently used for gramophones and records.

In 1931, The Gramophone Company and The Columbia Company merged as Electric and Musical Industries (EMI) and began manufacturing radios. The company made HMV radios in Australia from 1936 at 2-6 Parramatta Road, Homebush, NSW. The 1936 advertisements for HMV proclaimed that the radios were for "discriminating buyers who demand the best".

Circuit details

Fig.1 shows the circuit details of the HMV Model 456. It's a conventional 4-valve superheterodyne set with a 6A8G mixer-oscillator, a 6G8G IF amplifier/detector/first-audio stage, an EL33A (or EL3NG) audio output stage and a 5Y3G rectifier.

The set has a 457.5kHz IF stage, a conventional power transformer and an electrodynamic loudspeaker. It also has AGC and this is derived from the second diode in the 6G8G and applied to the first and second stages from the junction of R10 & R11.

Restoration

As with all such restorations, the first step was to remove and clean the chassis. For metal work in fair condition, I use turpentine and a brush to clean away the grime but this one required sterner treatment.

First, the valves were removed and the power transformer covered in plastic to make it waterproof. That done, degreaser was liberally sprayed over the top surfaces which were then brushed. The chassis was then hosed with water to remove the degreaser and

Also taken prior to restoration, this inside view shows the poor condition of the 2-core power lead (it had been joined at some stage in the set's past). The chassis and the valves were also dirty and the speaker cone had been punctured.

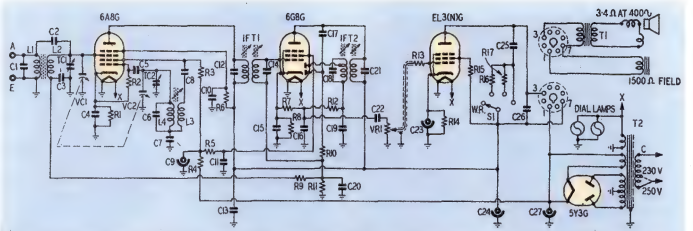


Fig.1: the circuit uses just four valves in a fairly conventional superhet arrangement, with AGC applied to the first two stages. The valve line-up includes a 6A8G mixer/oscillator, a 6G8G IF amplifier/detector/first audio stage, an EL33A/EL3NG audio output stage and a 5Y3G rectifier.

then blasted with compressed air to evaporate all visible remaining water.

I have learnt the hard way not to power a set up immediately after this sort of treatment, so the set was left for several days to completely dry. The electrolytics showed no signs of leakage so I didn't bother replacing them.

With the valves still out of circuit, I next connected my bench HT supply to the cathode pin of the 5Y3G rectifier. By the time I ramped up to 100V, the set was drawing 15mA, a clear sign that the electrolytics needed to reform. As a result, I backed off to give 10mA and then slowly increased the voltage in small steps to ensure that the current never exceeded 10mA.

After about three hours, the 450V electrolytics were happy to accept 330V at 2mA. The working radio subsequently settled at a HT of 340V, so I was not too far off by stopping at 330V.

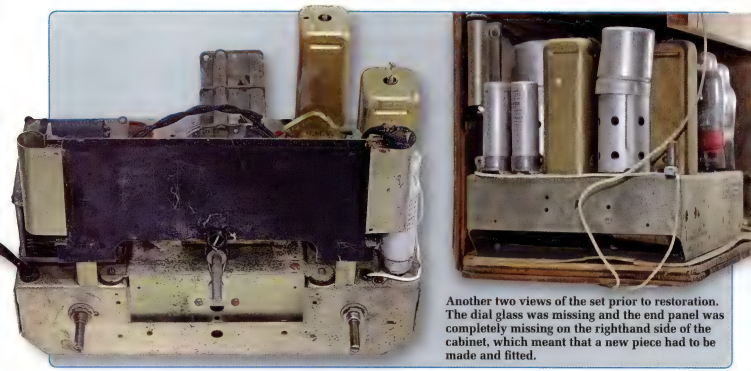
My next step was to replace the dodgy 2-core power lead with a modern 3-core lead, so that the chassis could be earthed.

Before reinstalling the valves, I did a high-voltage leakage test on the power transformer to ensure it had survived the chassis-washing process. It proved to be OK, so I then checked the two dial lights. These both had darkened glass envelopes, a classic symptom produced by the tungsten filaments slowly evaporating with long service.

Both dial lamps proved to be open circuit, a logical consequence of the filaments evaporating. As a result, the old globes were discarded and two new 6.3V 300mA (2W) globes installed.

Next came the anxious moment of first switch-on. I was expecting to see two brightly-lit dial lamps and about 5-6W showing on my power meter but that didn't happen. Instead, both lamps were off and the power meter was only showing 1W. At least this indicated that the power transformer had no shorted turns.

The problem with the dial lamps was easily diagnosed. The connecting lugs in the bases were insulated by an



Another two views of the set prior to restoration. The dial glass was missing and the end panel was completely missing on the righthand side of the cabinet, which meant that a new piece had to be made and fitted.

oxide layer that prevented good contact with the globe terminals. Cleaning them fixed that particular problem.

At this stage, everything was looking good. The power transformer was obviously OK and the electrolytics were accepting the applied HT without any signs of stress or undue leakage. As a result, the four octal valves and the speaker were plugged in and the set optimistically switched on.

The power consumption rose to a reasonable 44W but my optimism was misplaced because the only noise that came from the set was due to arcing inside the EL33A pentode valve. This was attended by a fine visual display of purple plasma in the envelope.

A classic symptom of a gassy tube is oxidation of the silvery magnesium "getter" that's deposited inside the envelope to absorb residual gas. However, this EL33A was externally painted in red near its base, so there was no visible clue.

It's interesting to note that some gassy tubes can still be functional (see www.thetubestore.com/Blue-Glow). I specifically recall a PA amplifier at my local townhall in the 1950s that remained working while the output valve glowed purple.

In this case, the old HMV's EL33A was headed for the bin of bad valves. With the EL33A removed, a signal tracer was connected to the slider of the volume pot and the radio switched on again. Result – nothing, absolutely nothing! There was no hiss or any hint of even the faintest reception. The power consumption was 28W, an aerial was in place and no components were overheating or showing any other signs of failure.

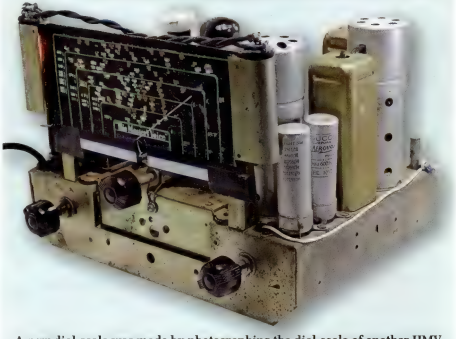
Troubleshooting the problem

Feeling somewhat disillusioned by this, I decided that the front-end fault just wasn't worth my time and so I left it, not intending to come back to it. However, after several weeks, it got the better of me and I decided to see if I could solve it.

Because the circuit is relatively simple, every component was tested and everything checked out fine. Admittedly, some of the resistors had gone high by up to 20% but this should not have resulted in a complete loss of function.

With no obvious faults present, I powered the set up again but as expected, it still didn't work. It was then left

Above: this view shows the chassis wiring of the HMV Model 456A. Very few of the original parts in the set required replacement.



A new dial-scale was made by photographing the dial-scale of another HMV set, then printing it out (after processing) and attaching it to the backplate.

The partially-restored chassis is shown at left, complete with its electromagnetic loudspeaker. The view at right shows the fully-restored chassis inside the cabinet, with the replacement audio output valve (a 6F6) fitted and a replacement speaker transformer.

on while I prodded each component in turn with an insulated rod to see if an audible crackle might reveal a dry joint or some other intermittent fault.

This drew a blank so I then decided to try wriggling the valves. As soon as I nudged the 6A8 mixer-oscillator, the set produced some hiss and a faint station could be heard through the signal tracer. I then adjusted the tuning gang over its full travel and the radio tuned in stations over almost the complete broadcast band. Judiciously bending one plate in the tuning gang restored its clearance and the set then covered the full MW range.

Unfortunately, the "cure" was short-lived because the radio soon fell back into complete silence and no amount of wriggling the 6AE8 or any of the other valves would restore normal operation.

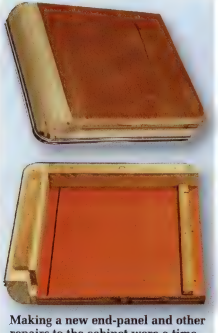
Hours of frustration then followed with the set occasionally springing to life but mostly failing to function. As a result, I began progressively replacing likely suspect components, including the 6A8, in an attempt to identify what seemed to be an intermittent. Even the electrolytic filter capacitors were replaced, despite the fact that they had been successfully reformed and appeared to be functioning normally.

In the end, the problem was solved by methodically measuring the voltages on the pins of the 6A8 mixer-oscillator. These measurements revealed that 113V was present on pin 4 when the set was functioning but only 10V when it wasn't.

Pin 4 is the screen adjacent to the 6A8's anode and the two components attached to it (C10 and R6) had been replaced without fixing the problem. In addition, the valve socket and the 6A8's pins had been cleaned and the valve inserted and removed a number of times to clean the contacts. But it hadn't been enough – pin 4 of the socket required extra attention to ensure a reliable contact.

And that was it – the radio then functioned reliably. I didn't have an EL33A output pentode in my valve drawer, so a 6F6 with comparable specifications was substituted. Unfortunately, the radio only worked for a few minutes with the replacement pentode in place before again going completely silent.

A few quick voltage checks revealed that there was no HT on the pentode's plate, indicating an open-circuit speaker transformer. This was subsequently confirmed by a resistance measurement and a replacement transformer restored operation.

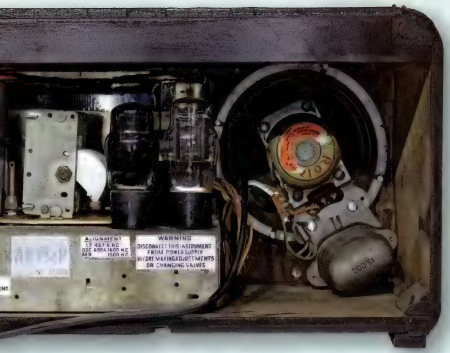


Making a new end-panel and other repairs to the cabinet were a time-consuming part of the restoration.

Restoring the cabinet

The old HMV 456 had lost both its dial glass and the pointer. A new pointer was made from white solid-core hook-up wire, so that problem was easy to solve.

The original dial was on the back of the glass, so that it sat in front of the pointer. Not having a replacement dial-glass, I decided that a printed dial-scale attached to the backplate would look reasonably authentic. This dial-scale was created by first photographing my model 886's dial and then modifying the image using



Arcing inside the EL33A pentode valve was accompanied by a fine visual display of purple plasma in the envelope, indicating that it had gone "gassy". The valve was replaced with a 6F6 which is a close equivalent.

photographic editing software (I use a freeware program called "The GIMP").

The editing involved extending the base-lines of the dial image and modifications to the contrast and brightness to turn a clear dial-scale into one with a black background. A sheet of clear glass was later fitted to the set in place of the original dial-glass.

The timber case was perhaps the most demanding part of the restoration because of its poor starting condition. The biggest job was making and fitting a new end piece. The remains of the original finish on the cabinet were then removed using paint stripper, after which it was sanded back and the veneer restored. It was then given the paint and polyurethane treatment so that it looked almost new.

A large hole in the original speaker grille cloth meant that this too had to be replaced. Whatever had penetrated this cloth had also punched a hole in the speaker cone which sits immediately behind it. This damage was repaired by cutting a patch from the cone of a non-functioning speaker and attaching it using PVA glue.

As shown in the lead photo, this all worked out quite well and the completed set looks quite authentic. The end product in now a worthy part of our radio heritage. SC

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PIC16LF88-I/P Garbage Reminder (Jan13)

PIC16LF88-I/SO LED Ladybird (Apr13)

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PIC18F45K80 USB Power Monitor (Dec12)

PIC18F4550-I/P GPS Car Computer (Jan10), GPS Boat Computer (Oct10)

PIC18F14K50 USB MIDIMate (Oct11)

PIC18F27J53-I/SP USB Data Logger (Dec10-Feb11)

PIC18LF14K22 Digital Spirit Level (Aug11), G-Force Meter (Nov11)

PIC18F1320-I/SO Intelligent Dimmer (Apr09)

PIC32MX795F512H-80I/PT Maximite (Mar11), miniMaximite (Nov11), Colour Maximite (Sept/Oct12)

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dsPIC33FJ64MC802-E/P Induction Motor Speed Controller (revised) (Aug13)

dsPIC33FJ128GP306-I/PT CLASSIC DAC (Feb-May 13)

ATTiny861 VVA Thermometer/Thermostat (Mar10), Rudder Position Indicator (Jul11)

ATTiny2313 Remote-Controlled Timer (Aug10)

ATMega48 Stereo DAC (Sep-Nov09)

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PRINTED CIRCUIT BOARDS

NOTE: These listings are for the PCB only – *not a full kit.* If you want a kit, contact the kit suppliers advertising in this issue.

PRINTED CIRCUIT BOARD TO SUIT PROJECT:	PUBLISHED:	PCB CODE:	Price:
AM RADIO TRANSMITTER	JAN 1993	06112921	$25.00
CHAMP: SINGLE CHIP AUDIO AMPLIFIER	FEB 1994	01102941	$5.00
PRECHAMP: 2-TRANSISTOR PREAMPLIER	JUL 1994	01107941	$5.00
HEAT CONTROLLER	JULY 1998	10307981	$10.00
MINIMITTER FM STEREO TRANSMITTER	APR 2001	06104911	$25.00
MICROMITTER FM STEREO TRANSMITTER	DEC 2002	06111021	$10.00
SMART SLAVE FLASH TRIGGER	JUL 2003	13107031	$10.00
12AX7 VALVE AUDIO PREAMPLIFIER	NOV 2003	01111031	$25.00
POOR MAN'S METAL LOCATOR	MAY 2004	04105041	$10.00
BALANCED MICROPHONE PREAMP	AUG 2004	01108041	$25.00
LITTLE JIM AM TRANSMITTER	JAN 2006	06101062	$25.00
POCKET TENS UNIT	JAN 2006	11101061	$25.00
STUDIO SERIES NB MODULE	APRIL 2006	01106061	$25.00
ULTRASONIC EAVESDROPPER	AUG 2006	01208061	$25.00
RIAA PREAMPLIFIER	AUG 2006	01108061	$25.00
GPS FREQUENCY REFERENCE (A) (IMPROVED)	MAR 2007	04103073	$30.00
GPS FREQUENCY REFERENCE DISPLAY (B)	MAR 2007	04103072	$20.00
KNOCK DETECTOR	JUNE 2007	05106071	$25.00
SPEAKER PROTECTION AND MUTING MODULE	JULY 2007	01207071	$20.00
CDI MODULE SMALL PETROL MOTORS	MAY 2008	05105081	$15.00
LED/LAMP FLASHER	SEP 2008	11309081	$10.00
12V SPEED CONTROLLER/DIMMER (Use Hot Wire Cutter PCB from Dec 2010 [18112101])			
USB-SENSING MAINS POWER SWITCH	JAN 2009	10101091	$45.00
DIGITAL AUDIO MILLIVOLTMETER	MAR 2009	04103091	$25.00
INTELLIGENT REMOTE-CONTROLLED DIMMER	APR 2009	10104091	$10.00
INPUT ATTENUATOR FOR DIG. AUDIO M'VOLTMETER	MAY 2009	04205091	$10.00
6-DIGIT GPS CLOCK	MAY 2009	04105091	$35.00
6-DIGIT GPS CLOCK DRIVER	JUNE 2009	07106091	$25.00
UHF ROLLING CODE TX	AUG 2009	15008091	$10.00
UHF ROLLING CODE RECEIVER	AUG 2009	15008092	$45.00
6-DIGIT GPS CLOCK AUTODIM ADD-ON	SEPT 2009	04208091	$10.00
STEREO DAC BALANCED OUTPUT BOARD	JAN 2010	01101101	$25.00
DIGITAL INSULATION METER	JUN 2010	04106101	$25.00
ELECTROLYTIC CAPACITOR REFORMER	AUG 2010	04108101	$55.00
ULTRASONIC ANTI-FOULING FOR BOATS	SEP 2010	04109101	$25.00
HEARING LOOP RECEIVER	SEP 2010	01208101	$10.00
S/PDIF/COAX TO TOSLINK CONVERTER	OCT 2010	01210101	$10.00
TOSLINK TO S/PDIF/COAX CONVERTER	OCT 2010	01210102	$10.00
DIGITAL LIGHTING CONTROLLER SLAVE UNIT	OCT 2010	16110102	$45.00
HEARING LOOP TESTER/LEVEL METER	NOV 2010	01111101	$25.00
UNIVERSAL USB DATA LOGGER	DEC 2010	04112101	$25.00
HOT WIRE CUTTER CONTROLLER	DEC 2010	18112101	$10.00
433MHZ SNIFFER	JAN 2011	06101111	$10.00
CRANIAL ELECTRICAL STIMULATION	JAN 2011	09101111	$30.00
HEARING LOOP SIGNAL CONDITIONER	JAN 2011	01101111	$30.00
LED DAZZLER	FEB 2011	16102111	$25.00
12/24V 3-STAGE MPPT SOLAR CHARGER	FEB 2011	14102111	$15.00
SIMPLE CHEAP 433MHZ LOCATOR	FEB 2011	06102111	$5.00
THE MAXIMITE	MAR 2011	06103111	$25.00
UNIVERSAL VOLTAGE REGULATOR	MAR 2011	18103111	$15.00
12V 20-120W SOLAR PANEL SIMULATOR	MAR 2011	04103111	$25.00
MICROPHONE NECK LOOP COUPLER	MAR 2011	01209101	$25.00
PORTABLE STEREO HEADPHONE AMP	APRIL 2011	01104111	$25.00
CHEAP 100V SPEAKER/LINE CHECKER	APRIL 2011	04104111	$10.00
PROJECTOR SPEED CONTROLLER	APRIL 2011	13104111	$10.00
SPORTSYNC AUDIO DELAY	MAY 2011	01105111	$30.00
100W DC-DC CONVERTER	MAY 2011	11105111	$25.00
PHONE LINE POLARITY CHECKER	MAY 2011	12105111	$10.00
20A 12/24V DC MOTOR SPEED CONTROLLER MK2	JUNE 2011	11106111	$25.00
USB STEREO RECORD/PLAYBACK	JUNE 2011	07106111	$25.00
VERSATIMER/SWITCH	JUNE 2011	19106111	$25.00
USB BREAKOUT BOX	JUNE 2011	04106111	$10.00
ULTRA-LD MK3 200W AMP MODULE	JULY 2011	01107111	$25.00
PORTABLE LIGHTNING DETECTOR	JULY 2011	04107111	$25.00
RUDDER INDICATOR FOR POWER BOATS (4 PCBs)	JULY 2011	20107111-4	$80 per set
VOX	JULY 2011	01207111	$25.00
ELECTRONIC STETHOSCOPE	AUG 2011	01108111	$25.00
DIGITAL SPIRIT LEVEL/INCLINOMETER	AUG 2011	04108111	$15.00
ULTRASONIC WATER TANK METER	SEP 2011	04109111	$25.00
ULTRA-LD MK2 AMPLIFIER UPGRADE	SEP 2011	01209111	$5.00
ULTRA-LD MK3 AMPLIFIER POWER SUPPLY	SEP 2011	01109111	$25.00
HIFI STEREO HEADPHONE AMPLIFIER	SEP 2011	01309111	$30.00
GPS FREQUENCY REFERENCE (IMPROVED)	SEP 2011	04103073	$30.00
DIGITAL LIGHTING CONTROLLER LED SLAVE	OCT 2011	16110111	$30.00
USB MIDIMATE	OCT 2011	23110111	$30.00
QUIZZICAL QUIZ GAME	OCT 2011	08110111	$30.00
ULTRA-LD MK3 PREAMP & REMOTE VOL CONTROL	NOV 2011	01111111	$30.00

PRINTED CIRCUIT BOARD TO SUIT PROJECT:	PUBLISHED:	PCB CODE:	Price:
ULTRA-LD MK3 INPUT SWITCHING MODUL	NOV 2011	01111112	$25.00
ULTRA-LD MK3 SWITCH MODULE	NOV 2011	01111113	$10.00
ZENER DIODE TESTER	NOV 2011	04111111	$20.00
MINIMAXIMITE	NOV 2011	07111111	$10.00
ADJUSTABLE REGULATED POWER SUPPLY	DEC 2011	18112111	$5.00
DIGITAL AUDIO DELAY	DEC 2011	01212111	$30.00
DIGITAL AUDIO DELAY Front & Rear Panels	DEC 2011	01212112/3	$20 per set
AM RADIO	JAN 2012	06101121	$10.00
STEREO AUDIO COMPRESSOR	JAN 2012	01201121	$30.00
STEREO AUDIO COMPRESSOR FRONT & REAR PANELS	JAN 2012	01201121/2	$20.00
3-INPUT AUDIO SELECTOR (SET OF 2 BOARDS)	JAN 2012	01101121/2	$30 per set
CRYSTAL DAC	FEB 2012	01102121	$30.00
SWITCHING REGULATOR	FEB 2012	18102121	$5.00
SEMTEST LOWER BOARD	MAR 2012	04103121	$40.00
SEMTEST UPPER BOARD	MAR 2012	04103122	$40.00
SEMTEST FRONT PANEL	MAR 2012	04103123	$75.00
INTERPLANETARY VOICE	MAR 2012	08102121	$10.00
12/24V 3-STAGE MPPT SOLAR CHARGER REV.A	MAR 2012	14102112	$20.00
SOFT START SUPPRESSOR	APR 2012	10104121	$10.00
RESISTANCE DECADE BOX	APR 2012	04104121	$20.00
RESISTANCE DECADE BOX PANEL/LID	APR 2012	04104122	$20.00
1.5kW INDUCTION MOTOR SPEED CONT. (New V2 PCB)	APR (DEC) 2012	10105122	$35.00
HIGH TEMPERATURE THERMOMETER MAIN PCB	MAY 2012	21105121	$30.00
HIGH TEMPERATURE THERMOMETER Front & Rear Panels	MAY 2012	21105122/3	$20 per set
MIX-IT!-4 CHANNEL MIXER	JUNE 2012	01106121	$20.00
PIC/AVR PROGRAMMING ADAPTOR BOARD	JUNE 2012	24105121	$30.00
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LED MUSICOLOUR	NOV 2012	16110121	$25.00
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CLASSIC-D CLASS D AMPLIFIER MODULE	NOV 2012	01108121	$30.00
CLASSIC-D 2 CHANNEL SPEAKER PROTECTOR	NOV 2012	01108122	$10.00
HIGH ENERGY ELECTRONIC IGNITION SYSTEM	DEC 2012	05110121	$10.00
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1.5kW INDUCTION MOTOR SPEED CONTROLLER (NEW V2 PCB)	DEC 2012	10105122	$35.00
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2.5GHz DIGITAL FREQUENCY METER – DISPLAY BOARD	JAN 2013	04111122	$15.00
2.5GHz DIGITAL FREQUENCY METER – FRONT PANEL	JAN 2013	04111123	$45.00
SEISMOGRAPH MK2	FEB 2013	21102131	$20.00
MOBILE PHONE RING EXTENDER	FEB 2013	12110121	$10.00
GPS 1PPS TIMEBASE	FEB 2013	04103131	$10.00
LED TORCH DRIVER	MAR 2013	16102131	$5.00
CLASSIC DAC MAIN PCB	APR 2013	01102131	$40.00
CLASSIC DAC FRONT & REAR PANEL PCBs	APR 2013	01102132/3	$30.00
GPS USB TIMEBASE	APR 2013	04104131	$15.00
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CLASSIC-D 12V to ±35V DC/DC CONVERTER	MAY 2013	11104131	$15.00
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LF/HF UP-CONVERTER	JUN 2013	07106131	$10.00
10-CHANNEL REMOTE CONTROL RECEIVER	JUN 2013	15106131	$15.00
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L'IL PULSER MKII FRONT & REAR PANELS	JULY 2013	09107132/3	$20.00/set
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Wants HDMI input for CLASSiC DAC

Bravo for the series of articles on the new CLASSiC DAC (SILICON CHIP, February-May 2013). I am looking forward to building one. Can an HDMI connection be implemented for audio? (M. C., via email).

● We have looked looked into including HDMI for the CLASSiC DAC. There are chips to do the conversion but they are quite expensive and have lots of pins. They also require encryption keys on an external EEPROM which presents a number of further hurdles. This is why HDMI is so annoying, with all the DRM limitations on it.

It'd probably be easier and cheaper to buy an HDMI to S/PDIF or TOSLINK adaptor and hook it up to the DAC. For example: www.aliexpress.com/item/Free-Shipping-HDMI-4x1-HIFI-Switch-Separate-Toslink-Coaxial-Stereo-Audio-V1-3b/935342009.html

In theory, that would give us a DAC with say three TOSLINK, two S/PDIF, one USB and four HDMI inputs.

Software defined radio for 2.4GHz band

Your May 2013 Software Defined Radio (SDR) is a great project but can anything be done to extend the range to include the 2.4-2.4835GHz ISM band? It would then be a useful tool for people like me who are trying to find a quiet channel when using the RF24L01 transceivers etc. (G. F., via email).

● As far as we know, none of the DVB-T dongles currently available are able to tune beyond 2.2GHz. So the only way to achieve an SDR covering the 2.4-2.4835GHz band (using a low-cost dongle) would be to design a down-converter to go ahead of the dongle, somewhat like the up-converter we have published in the June issue.

However, such a down-converter could be a lot harder to design than our low-cost up-converter.

Queries on Speedo Corrector

I have a BTR 4-speed auto in a hot rod. The speedo and sender are Dolfin brand and work with 250 pulses/km. The gearbox TCM needs about 5550 pulses per kilometre or about 20 times the pulses from the sender.

Can I wire the Speedo Corrector to multiply by 20? If so, could you advise how? (R. S., via email).

● The speedo corrector is not capable of multiplying by 20. It can only multiply by up to 1.99 but not 20.

Instead, the phase lock loop circuit section from the 5-Digit Tachometer (published in October 1997) could be used to provide the x 20 multiplication of the incoming signal. This phase lock loop can be set to multiply anywhere between x1 and x270 in steps of 1. This circuitry comprises IC2 (a 4046 phase lock loop) and IC3 and IC4 (4526 programmable dividers).

Depending on the output signal of the speedo sender, you may need to use the input signal conditioning circuit comprising IC1 (an LM393 comparator) and Q1. The signal should be able to be applied to the low-signal input section of the circuit.

DAC for TV sound

Being of a more senior age I find that my hearing is not what it once was. It's not really a problem until I try to listen to the audio from my television; it always seems to be blurred and sort or faint. I want to run external speakers in the hope that better speakers would do the trick for me.

I looked for an analog output from my Sony television without any luck but did find a digital/optical output. So my question is, how can I connect this outlet to my speakers? (J. B., via email).

● One practical solution to your dilemma (a common one) is to use our CLASSiC DAC project (February-May

Query On Solar Charge Controller

With reference to the circuit description of the Solar Charge Controller on page 42 of the February 2011 issue of SILICON CHIP: when the PWM signal switches Q1 off, the text states that Q3 conducts and connects the gate of Q1 to the source voltage which makes Q1 non-conducting.

I can see that Q3 would do this but only for the discharge time of the charged capacitance inherent with the source-gate junction. After this time, there is no negative potential on the emitter of Q3, so this becomes non-conducting and the gate seems to be floating.

Where have I gone wrong? Please tell me so that I can sleep at nights. (H. W., via email).

● Transistor Q3 does only switch on and discharge the gate of Mosfet Q1 and then is off once there is no base voltage remaining.

Q1's gate is then, in effect, floating but the gate will remain discharged (at the source voltage) due to gate capacitance holding the discharge voltage. Should the gate charge up due to noise or other reasons, then Q3 will switch on as the emitter voltage begins to drop below the base. However, then Q3 will switch on and prevent the gate dropping by any further than about 0.6V (in practice at about 0.3V) below the source.

Since Q1 requires far more gate voltage than 0.6V in order to switch on, it remains off.

We trust that you can now rest easy at night, knowing that the Mosfet does switch off properly.

2013) to decode the optical outputs from your TV. You can then listen to headphones from the DAC or connect the DAC's analog outputs to a stereo amplifier and your speakers. Unfortunately, there's no kit for the DAC project but we can provide the PCB, micro and some of the key components.

Failing that, you need to check out a surround amplifier from JB Hi-Fi or one of the other retailers. This should give you the choice of HDMI or Toslink inputs.

Soft Starter current rating

With regard to the Soft Starter project in the April 2012 issue, please advise the maximum current rating at 240VAC. Can the unit be used on inductive loads like a power transformer primary? (M. S., via email).

- The PCB is designed to handle 10A and the NTC thermistor is rated for 15A. The main limit is the relay, which is rated at 1500VA/240W.

We think the 240W figure is for a motor load and assumes no current limiting. For a transformer, the 1500VA rating is a better guide. So in theory at least, the unit should be OK for quite a large transformer.

If you want to play it safe, you could use the alternative JQX-105F-24 relay. This is rated for up to 7200VA and 30A. With that relay, the Soft Starter should handle just about any load that can be connected to a 10A GPO.

Using the Soft Starter with a fridge

I have a domestic refrigerator, with a running current of 1.6A and a starting current of 13A. I would like to run this from a 3kVA generator but the inrush current on fridge start-up is causing the generator voltage to sag from 240VAC to about 210VAC. I think the under-voltage cut-out on the fridge prevents it starting. Then the fridge tries to start again after about 30 seconds and the cycle continues.

Has anyone tried your Soft Starter on a refrigerator to reduce the starting current? It maybe that it will not work due to the refrigerator under-voltage cut-out. Perhaps the Soft Starter delay time (before applying full power) has to be reduced to beat the under-voltage cut-out operating?

I notice that there are two Soft Starters, one in April 2012 and the other in July 2012. Which do you think would be more suitable? Ideally, it should be possible to adjust how long it takes to apply full mains power.

In the refrigerator sealed units, do you know what type of motor is used? How is it started? Is there a centrifugal switch to remove power from the starter winding once the motor has started? I have read that refrigeration sealed units do not have a centrifugal switch for motor starting as this would cause sparking and this would cause problems with the oil inside. So perhaps they use capacitor run motors?

I have also read that there are different types of compressors: piston and rotary. Perhaps the surge current is dependent on the compressor type. I noticed that a newer fridge with a running current of 1.2A had a surge of 7A (6:1 ratio). This is better than my refrigerator. (R. S., via email).

- While it is possible that a Soft Starter could help with your surge

Hum Problems In CLASSiC-D Amplifier

I have built two CLASSiC-D amplifier modules (Silicon Chip, November & December 2012) and assembled them together with the associated power supply and speaker protector into an Altronics 2-unit rack case. I have shielded the transformer using the same method as for the Studio Series Stereo Preamp rather than add the copper shielding as described in the CLASSiC-D instructions. I have also built the Studio Series Stereo Preamp and ran into hum problems when it was connected to the CLASSiC-D amplifier.

This was mainly fixed as described in the Studio Series instructions by removing the earth wire from the preamp board. With an ear close to the speaker grille, some hum can just be heard (without any audio inputs connected). I wondered if this could be due to the layout of the CLASSiC-D components in the case or the shielding method I have adopted. At a metre or so away from the speakers the hum is not noticeable and sound from a Denon CD player connected to the preamp is OK.

Would shielding the transformer with the copper band as described be likely to reduce the level of hum better than the metal partition that I have used?

I have also built the DAB+/FM Stereo Tuner and when connected to the Studio Series Preamp it produces quite noticeable hum. I have tried reconnecting the earth wire to the Studio Series preamp board and disconnecting the internal audio shielding at the inputs of the CLASSiC-D. This reduces the hum but it is still noticeable.

Is there anything else I can try to remove the hum from the Tuner/Preamp connection? Does it have anything to do with the tuner getting its power from a plugpack? (D. H., Maleny, Qld).

- The hum should be fixed by earthing the ground input of the CLASSiC-D amplifier to mains earth (chassis) at the input RCA sockets on the rear of the chassis and connecting each of the heatsinks to chassis rather than the earth connection on the PCB. The 10Ω earth isolation resistors might be better shunted on one or two of the amplifiers.

The hum is not likely to be from the transformer. In any case, a copper strap is better at eliminating any hum caused by the transformer than a steel shield.

There shouldn't be any mains earthing of the signal ground used in the DAB tuner or preamp. That way, any hum due to earth currents should be minimal.

The AC plugpack supply for the DAB tuner may introduce hum since the wires run close to the signal output and they have significant peak charging current flowing in the wires. Try removing the loop through wiring in the holes near the RCA output and just run the wires to the screw terminals, keeping them away from the RCA output.

Connecting the RCA earth to chassis may also help as the chassis will then be earthed via the earthed connection on the CLASSiC-D amplifier. The antenna socket then may require the shield to be isolated from the back panel to prevent an earth loop between the antenna ground on the receiver module and the audio output RCA sockets.

Poor Waveforms From Digital Audio Signal Generator

I wonder if you can help me with a problem I'm having with the Digital Audio Signal Generator (March/April/May 2010). I've just finished constructing a kit from Altronics and the square and triangular waveforms are not true to shape.

Everything checks out OK. The menus work just fine and the 1kHz waveforms of all types look pretty much like those shown on page 77 of the May 2010 issue. However, when the frequency is increased, the square and triangular waveforms become less and less like their namesakes. By 24kHz, the triangular wave has degenerated to more like a sinewave, while the square wave develops large lumps and bumps where it is supposed to be flat.

At sub-multiples of the sampling frequency (either 48kHz or 96kHz), the shape often resembles the double-hump response curve of an IF amplifier coil whose primary and secondary have been tuned to slightly different frequencies. At other frequencies, the output is nothing like a square wave.

I note that there have been revisions of the software. I have obtained a new chip known definitely to have version "C" of the software but with no improvement. Where should I look to solve this problem? (J. H., via email).

● Those sample waveform pics you sent are what we would expect from a digital synthesis waveform generator operating at audio sampling frequencies. With a sampling rate of, say 48kHz, the Nyquist limit is 24kHz and so any harmonics of the waveforms above that frequency cannot be reproduced.

That effectively means that anything over 12kHz is going to look much like a sinewave and frequencies not much lower than that will be significantly rounded.

This is a limitation of most DDS generators although those that are not designed for hifi audio use generally have less vertical resolution (ie, a lower bit depth) and more horizontal resolution (ie, a faster sampling rate) and thus can generate waves with sharper edges up to higher frequencies. But even a DDS advertising operation to 50MHz won't give you a square or triangle wave at anywhere near 50MHz. You're lucky to get something approaching a square wave up to 5MHz and a triangle wave up to 1MHz with such a device.

We could have explicitly limited the square/triangle frequencies, like those DDS generators tend to do, to frequencies at which the shape is close to what you would expect but decided instead that the user should have the flexibility to select the frequency they want with the knowledge that at higher frequencies, they will be significantly rounded.

If you want a squarer wave, try using the maximum sampling rate of 96kHz (with the "analog" setting). You could also try changing the output low-pass filter components to move the corner frequency higher.

current problem, we generally don't recommend using it with fridges/freezers and so on. That's because compressor motors inevitably pull a fair amount of current when they start due to the fact that they start "on load" and that they are induction motors. The risk is that with a soft starter, the initial current may be limited to the point that the compressor might not actually start. This could potentially cause damage to the soft starter and/or the compressor motor.

Having said that, it will probably be OK in your case since the surge currents you have mentioned are not especially high and the NTC thermistor we have specified should handle it. A surge current of up to about 10 times the run current is not uncommon.

If the compressor doesn't start immediately with the Soft Starter in circuit, hopefully the thermistor resistance will drop quickly enough that it will start shortly afterwards. You will need to be careful to check that it starts reliably with the Soft Starter connected though. Don't leave it unattended until you are convinced that it is operating reliably.

By the way, you should only use the later version of the Soft Starter (ie, July 2012, designed for power tools). The original Soft Starter only suppresses inrush currents when power is first applied so that's no good for any device with a thermostat which will be turning the compressor on and off over time.

It's necessary to change at least one component to alter the delay. Normally, the delay is not critical as the initial inrush spike is relatively brief but in some situations adjustments may be necessary. For the Soft Starter for Power Tools, the delay can be increased by using a higher value capacitor in place of the capacitor which is connected to the junction of the 2.2MΩ and 3.3MΩ resistors. Try a value of 330nF.

New siren driver circuit wanted

I am wanting to build a new siren driver to replace the crook one that's in the satellite alarm box on my house. I have looked around the net for circuits and have come across what I think is a good one using a ZSD100 siren driver IC driving an H-bridge. Unfortunately, this IC appears to be discontinued and is no longer available.

I have trawled the net looking for a substitute for this IC but without success. Are you able to suggest a suitable replacement for this IC or have you published a complete siren design of your own that I could make up? (P. W., via email).

● Possibly the demise of the Zetex ZSD100 siren driver is due to lack of demand because many sirens already incorporate a driver to give a pulsating tone.

We published a suitable siren driver in October 1990. It uses a 40106 hex Schmitt trigger and transistor H-bridge. Oatley Electronics developed this but it is not available from them now as a kit. However, the circuit uses commonly available parts.

New life for a dead golf buggy

This is being sent to you because I have seen your June 2011 DC Motor Speed Controller. My wife's golf buggy has died. The battery is OK and the motor is OK so the fault is in the control circuit. I have checked all the connections and it boils down

to the epoxy-potted control box. The buggy repairman also tested it and pronounced it dead. The replacement cost is $200; unbelievable!

I have two circuits that could do the job. The first is what I would call a "linear" controller – essentially a current controller. It works OK with the motor but is unlikely to be very "heat efficient". The four IRF540 Mosfets are mounted on a heatsink.

The second circuit is a simple PWM driver for the IRF540s. I haven't tried it yet as I thought you may have some comments.

The failed controller is rated at 30-35A. Under "strain", the motor current draw is about 30A. What I don't know is how many IRF540s are needed to get to say, 40A or 50A. Probably only two? I don't understand the rating of high powered Mosfets.

I note that your June 1997 motor control circuit rated at 20A uses two BUK456-60As. I would have thought this would give a rating of 120A for the controller so it seems considerable de-rating is used for some reason.

Full power (probably about 30A) would be required for less than a minute and most of the time the current would be only 2-10A. Ideally, a resettable cut-out (at say, 40A) would be great but I haven't factored that in. Perhaps a slow blow fuse of about 35A might do the trick?

Anyway, it would seem that your June 2011 circuit will not cut the mustard at the high current levels expected in the buggy. So I would like to try the IRF540 PWM circuit attached. Do you think it will work? (J. K., via email).

● The IRF540 has a 33A current rating and 44 milliohms resistance between drain and source when fully turned on. That is at a junction temperature of 25°C and needs to be de-rated by 0.87W per °C above this. The BUK456-60A requires only a de-rating of 6.6mW per °C.

According to the graphs for the IRF540, the V_{ds} will be 1V at 10A at 175°C junction temperature and about 0.6V at 10A and 25°C junction temperature. The dissipation, assuming 30A through three devices in parallel, will be approximately 1V x 30A/3 = 10W each or 30W in total. That needs considerable heatsinking.

The switching circuit you show with the pin 7 output driving the Mosfet gates does not have sufficient gate drive using the 10kΩ pull-up resistor. It would be better to use 4050 CMOS buffers to drive the Mosfets.

In addition, gate protection should be included, with 15V zener diodes between each Mosfet's gate to source to prevent excessive gate voltage. The MBR2010 diodes should be suitable across the motor.

You could use our 20A motor controller for short term use up to 30A, provided that the heatsinking proves adequate.

Questions On Hearing Loop Signal Conditioner

John Clarke published a Hearing Loop Signal Conditioner (in the January 2011 issue) which I recently purchased. My interest is in the gyrator treble boost.

I understand the simulated inductor but have questions about the four resistors and potentiometer around the gyrator circuit. Why are the 10kΩ, 51kΩ, 47Ω and 27kΩ values chosen? What do they do in the circuit? What about the value of the 50kΩ potentiometer?

The other gyrator circuits I've seen don't have a resistor in the 47Ω position. I couldn't find any information online explaining this part of the circuit but there was plenty about the gyrator. (J. G., via email).

● The equaliser circuit is unconventional in that we only set it up for treble boost rather than treble boost and treble cut with VR3. The 47Ω resistor is there to limit the maximum treble boost. The 51kΩ resistor is there so the with VR3's wiper fully toward the 51kΩ resistor, the treble cut is 0dB.

With the 51kΩ resistor replaced with a 47Ω resistor, there would be treble cut available and we do not want that in this circuit. VR3 is set at the same value as the 51kΩ resistor to provide for the 0dB setting. The 10kΩ resistor increases the input impedance to the equaliser circuitry.

More information of equaliser design is available at: **www.geofex.com/article_folders/eqs/paramet.htm** and **www.forsselltech.com/media/attachments/Evolution_of_an_EQ_Design2.pdf**

Tinnitus and headphones

I am a classical music buff with the best hifi sound system in the world. Tinnitus has hit me with a disastrous blow to my music listening.

I have a SILICON CHIP 20W Class-A Stereo Amplifier and Kapellmeister

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Ask SILICON CHIP
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speaker enclosures I cannot listen to anymore. Can you come up with a loop system or connection with earphones? (A. H., via email).

● We published a hearing-aid loop receiver in September 2010 and a signal conditioner for a loop drive amplifier in September 2011. The September and October 2011 issues had feature articles on installing a hearing aid loop – see **www.siliconchip.com.au** for these articles. Altronics (**www.altronics.com.au**) have the kit for the hearing loop receiver (Cat K5547).

However, we cannot see how using headphones will solve the problem; instead, it might make it worse. Tinnitus has a number of causes, including excessive exposure to loud noise (music?) but there can be more serious causes, including Meniere's disease. In some cases, Tinnitus can gradually fade but you would be wise to consult your doctor if you haven't done so.

Current boost regulator circuit gets too hot

This question is not regarding a SILICON CHIP article but refers to a circuit in the Jaycar catalog on page 198 labelled "increasing the output current". I require a 12V DC power supply at around 2A and I reasoned

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Ask SILICON CHIP
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that this circuit would meet my needs. Accordingly, I built the circuit on a Veroboard layout.

I have doubled-checked, even-triple checked, my layout and can find no fault, however even with a modest load of half an amp the 7812 becomes so hot it is impossible to touch it within 15-20 seconds. Surely this is not normal? I have checked the pinout of the TIP2955 and the 7812 and as I mentioned earlier, cannot fault my layout connections.

I know this is presumptuous of me but is the circuit and component listing correct to provide the resultant 12V at up to 3A? Could you perhaps suggest an alternative power supply, published by SILICON CHIP, that I could use? (K. J., via email).

● That Jaycar current boost circuit is fairly standard (see **www.elecircuit.com/boosting-regulator-current-for-ic-78xx-by-mj2955/**).

The 3.3Ω resistor between the base and emitter of the TIP2955 means that there will be 0.6V across the resistor when the transistor is conducting, allowing the transistor to bypass some of the current that would otherwise pass through the regulator to the output. When the transistor is conducting, the current supplied by the regulator will be 0.6V/3.3Ω or 182mA.

Whether the regulator runs hot or not when delivering current depends on the voltage difference between the input and output. If you are feeding in, say, 15V to the input for a 12V output, there is about 3V minus the 0.6V drop across the 3.3Ω resistor. The regulator then dissipates 2.4V x 182mA or 437mW.

The thermal resistance of a TO-3 package is typically 4°C/W junction to case and 35°C/W case to ambient. The thermal resistance of a TO-220 package is typically 4°C/W junction to case and 50°C/W case to ambient.

So for a TO-3 package, the regulator will run some 39°C/W x 437mW. That's 17°C above the ambient temperature. For a TO-220 style package, the regulator will run at 54°C/W x 437mW or 23.6°C above ambient.

The 23.6°C above ambient (for a TO-220 device) would mean that the regulator tab will be 48.6°C and that is fairly hot. If you have a higher input voltage, then the regulator will run hotter again.

One way to reduce temperature is to reduce power dissipation within the regulator. To do that, the input voltage needs to be reduced. Note that you do require at least 2V between the input and output of the regulator in order to maintain output regulation. Otherwise, use a heatsink to keep the regulator running cooler. SC

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Notes & Errata

CLASSiC DAC, February-May 2013: the element14 part number listed for the AP5002S IC was wrong (page 41, April 2013). It should be 1825351.

Demonstration Circuits for Human Colour Vision, July 2013: The RGB LED specified for the circuit of Fig.3 is a common cathode type and its Jaycar catalog number is ZD-0012. Do not use the ZD-0010 which is a common anode type.

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Engineers File Set - Second Cut

- 200mm hardened and tempered files
- Second cut: Flat, 1/2 Round, Round, Square, Triangular
- Includes carry case

~~$31.50~~ **$25** (F100)

GREAT VALUE

9" Drill Press Locking Clamp

- 2" jaw opening
- Quick release lever
- Swivelling jaw pad

~~$19.50~~ **$16.50** (C103)

VICE GRIP

Digital Calipers

- Metric, inch & fraction
- 4-way measuring
- Includes battery

150mm/6"	200mm/8"
~~$31.50~~ **$29** (M738)	~~$49.50~~ **$44** (M739)

ACCURATE

Countersink Set

- HSS M2 Bright Finish
- 02 - 020mm
- Cross hole type
- Angle 45°
- 4 piece set

~~$66~~ **$59** (D1051)

Precision Jobber Drill Set

- 51 piece set
- 1-6mm in 0.1mm steps
- HSS M2 precision ground

~~$99~~ **$89** (D1285)

RP7834 Air Tool Kit

- 1/2" impact gun
- 1/4" die grinder
- 3/8" ratchet wrench
- Air hammer & chisel set

~~$176~~ **$159** (A053)

Carbide Burr Sets

- Industrial quality multi-purpose burrs
- Double cut burrs
- 5 piece set

CUT STEEL

Short Series	Long Series
• SD-3, SE-3, SA-3, SC-3, SF-5 • 1/4" x 1-1/2" shank	• SD-3, SD-5, SG-5, SC-5, SF-5 • 1/4" x 6" shank
~~$86.50~~ **$79** (B900)	~~$99~~ **$89** (B905)

SBD-20B Bench Drill

- 16mm drill capacity
- 2MT, 16 spindle speeds
- Swivel & tilt table
- 1hp, 240V motor

~~$297~~ **$279** (D138)

MUST HAVE

EDBD-13 Drill Sharpener

- 3-13mm or 1/8"-1/2"
- Diamond wheels
- Split point
- 80W, 240V motor

~~$99~~ **$89** (D070)

SUPER 12 Air Compressor

- 348 L/min V twin pump
- 58 litre tank
- 120psi pressure
- 2.2hp, 240V motor

$795 (C340)

Includes FREE 15M Air Hose (H008)

FAST AIR

AL-60M Lathe Mill Drill Combination Package

AL-60 Bench Lathe:
- 250 x 600mm capacity
- 20mm spindle bore
- 6 speeds 125-2000rpm
- 0.75hp 240V motor

HM-10A Mill Head:
- 2-speed gearbox
- Head tilts -25° to 45°
- Variable speeds 100-2500rpm
- Includes 110x245mm table
- 0.5hp, 240V motor

SAVE $96

PACKAGE DEAL

~~$1,991~~ **$1,895** (K160)

HM-10 Mini Mill Drill

- Dovetail column
- 2 speed gearbox
- Head tilts ±45°
- 350W 240V motor
- Travels:
  (X) 225mm
  (Y) 100mm
  (Z) 190mm

~~$759~~ **$729** (M150)

COMPACT

WBS-3D Work Bench

- 2000 x 640 x 870mm
- 3 Lockable drawers
- Bearing slide drawers
- Huge shelf compartment

~~$396~~ **$369** (A380)

HEAVY DUTY

ORDER NOW!

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